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ENERGY IN EUROPE

Energy policies and trends in the European Community

Number 12 March 1989

Commission of the European Communities □ Directorate-General for Energy

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Contents

Abbreviations and symbols

:	no data available
-	nil
0	figure less than half the unit used
kg oe	kilogram of oil equivalent (41 860 kjoules NCV/kg)
M	million (10^6)
t	tonne (metric ton)
t = t	tonne for tonne
toe	tonne of oil equivalent (41 860 kjoules NCV/kg)
fob	free on board
cif	cost-insurance-freight
MW	megawatt = 10^3 kWh
kWh	kilowatt hour
GWh	gigawatt hour = 10^6 kWh
J	joule
kJ	kilojoule
TJ	terajoule = 10^9 kJ
NCV	net calorific value
GCV	gross calorific value
ECU	European currency unit. The ECU is a composite monetary unit consisting of a basket of the following amounts of each Community currency:

BFR	3.71	HFL	0.256
DKR	0.219	IRL	0.00871
DM	0.719	LIT	140
DR	1.15	LFR	0.14
FF	1.31	UKL	0.0878

USD	US dollar
EUR 10	Total of member countries of the EC before accession of Spain and Portugal in 1986
EUR 12	Total of member countries of the EC
I or —	discontinuity in series
of which	the words 'of which' indicate the presence of all the subdivisions of the total
among which	the words 'among which' indicate the presence of certain subdivisions only

Message from Constantinos Maniatopoulos — Director-General for Energy

The year 1988 witnessed a milestone in the energy policy of the Community — the launching of the internal energy market — endorsed by the Energy Council at its meeting on 8 November 1988. This event was made possible thanks to the ceaseless efforts and personal involvement of Mr Nic MOSAR, the Commissioner for Energy until the end of 1988.

Included in this issue of Energy in Europe, *is a short analysis of the document presented by the Commission to the Energy Council on the subject and the full text of the Council's conclusions.*

It now rests with the new Commission to respond to the challenge of the internal energy market and to advance, with determination, towards its completion.

The preparation of the necessary proposals in this area already has top priority in the Directorate-General for Energy and work has started on a number of different aspects of the internal energy market.

I am aware that the task will be difficult. But I am convinced that under the impulse of the President of the Commission and the authority of the new Commissioner for Energy, Antonio CARDOSO E CUNHA, our sector will make the necessary leap forward, through an increasing convergence of national policies, to arrive at a common energy policy.

New Commissioner for Energy

In January 1989, the new Commission took up its responsibilities under the Presidency of Mr Jacques Delors. The Commissioner with responsibility for energy in the new Commission is Mr Antonio CARDOSO E CUNHA who replaces Mr Nic Mosar.

Mr Cardoso e Cunha is a graduate from an institute for chemical and industrial engineering. From 1965 to 1976 he was the president and director-general of a large group of private companies operating in Angola. He then became director of several private sector companies in Portugal before becoming Secretary of State for External Trade in 1978 and Secretary of State for Manufacturing Industries in 1979. In January 1980 he was appointed Minister for Agriculture and Fisheries.

Following the adhesion of Portugal to the European Communities in January 1986, Mr Cardoso e Cunha was appointed as Commissioner with special responsibilities for Fisheries.

In addition to energy, his new responsibilities also include personnel, administration and translation, the Euratom Supply Agency, small businesses, distributive trades and tourism and cooperatives.

Mr Cardoso e Cunha is 55 years old, married with four children.

Introduction

First of all we must apologize for the lateness of this issue of Energy in Europe. *The main reason for the delay is a very important event that will occur in the future — the completion of the internal market (1992 and all that!) This has significantly increased the workload of many — if not all — of the Directorates-General. It has also played havoc with the schedule of the Office for Official Publications of the European Communities where it was necessary to give priority to publications directly relating to the opening up of the internal market. These publications included the publication in December — in nine languages — of our study on the internal energy market as a special issue of* Energy in Europe.

The internal energy market — agreed by the Energy Council in November 1988 — is an area of the highest priority for us. This is made clear in the message from our Director-General, Constantinos Maniatopoulos, and the first article in this issue.

This Energy in Europe *contains the largest number of articles that we have ever published in one issue. They address a wide variety of subjects spanning nearly all the aspects of Community energy policy. The article on the oil market and the refining industry — recent developments and prospects to 1995 — covers the communication from the Commission to the Council which was the latest in a series of reports on progress made in combating the problems which have beset the refining industry in the Community over the last 10 years. After some discussion, the November Energy Council failed to reach agreement on this report. They did however adopt a Recommendation on the promotion of cooperation between public utilities and auto-producers of electricity described in the article on privately generated electricity — a way to save primary energy. The next article is based on a subject — efficiency of electricity use — which was also introduced into the November Council but is likely to be debated at the next Energy Council in April 1989.*

The articles on the Federal Republic of Germany and on the supply of uranium to the Community are the next ones in the series describing the energy situation in Member States and the Community's energy supplies respectively. The article describing the financial support from the Community to the energy sector, in this instance during 1987, is an annual feature of Energy in Europe. *This is followed by a short report describing the results of the support programme for technological development in the oil and gas sector (to December 1987) and a brief report on one of the projects supported.*

The good news — according to the article on energy efficiency — is that improvements in the efficiency of energy use continue to contribute to reducing demand. The bad news is that the rate at which we are improving efficiency is already slowing down.

Nuclear energy in the context of the large European market and the challenges it faces is discussed in a paper which attempts to assess what contribution can be made by nuclear power to Europe in the future.

For several years, the Community has been cooperating closely with China in the energy field. In 1985 a new dimension was added to this programme in the form of cooperation on natural gas prospecting and production technology. Details of the project in the Shan-Gan-Ning Basin are described here in a short article.

In June 1988, the Committee of Inquiry set up by the European Parliament to investigate the Transnuklear-Mol Affair submitted its report. This was debated in the Parliament in July when a resolution was passed based on the report's findings. Details of the resolution and the speeches made by Commissioner Mosar (Energy and the Euratom Supply Agency) and Commissioner Clinton Davis (Nuclear Safety, Environment and Transport) are presented here.

The last two articles contain the short-term outlook for the Community (which includes our first forecast for 1989) and an assessment of the accuracy of previous forecasts. We invite comments on, or questions about our forecasts. We are also proposing to set up a system whereby our data could be obtained on diskette. Those interested in this service should contact the Editor.

To round off what has been a very important and busy year for DG XVII, there are a large number of items in the Community news section ranging from a report on the November Energy Council to an advertisement for a video 'Anaerobic digestion.' Even our 'Document update' is longer than usual this time.

So we hope you enjoy our 'bumper issue' — and excuse us for its late arrival.

Energy in the internal European market (1992)[1]

1. Background

With the implementation last year in July of the Single European Act, reinforced by the decision in February this year of the European Council to assign the resources needed for the Community to make a success of the Single Act, the way is clear for making a reality of the European Community internal market. Completion of the internal market by the end of 1992 has become a key objective and the focal point for the rejuvenation of the European Community.

Energy was one of those areas not directly part of the package of proposals for realizing the internal market contained in the Commission's White Paper of 1985.[2] Neither was it directly referred to in the Single Act. The Commissioner for Energy, Nic Mosar, at the Energy Council in Luxembourg on 2 June 1987, announced the Commission's intention to draw up an inventory of existing obstacles to the internal energy market and in due course to submit proposals for their elimination before the end of 1992. Energy Ministers welcomed and endorsed the plan. The initiative was welcomed, too, by two other Community institutions, the European Parliament and the Economic and Social Committee.

This work was duly completed by the Commission after extensive consultation with Member States and organizations and enterprises from all Member States, representing all principal energy sources and including both energy producers and consumers. The result was the Commission Working Document, published on 2 May 1988, entitled 'The internal energy market'.[3]

2. Purpose and benefits

The internal energy market means a Community energy market which is better integrated than today's and free from barriers to trade. The cost to the Community economy of these barriers is considerable. It is estimated in the Commission report entitled 'Europe 1992 — the global challenge', published in March 1988, that the cost of 'non-Europe' in the energy sector could be as much as 0.5-1.0% of Community GDP or ECU 20-30 billion per year. To put this into perspective, this is equivalent to around the whole of Ireland's GDP or nearly one quarter of Denmark's GDP.

The benefits of an internal market in energy are clear. Without barriers to trade, there will be greater competition within the energy market, resulting in a more optimal allocation of energy resources and lower energy prices. This will benefit Community energy consumers and in turn increase the competitiveness of Community industry in world markets, securing investment and employment, etc. It will also improve the structure and efficiency of the Community energy industry and increase the flexibility and security of energy supplies. Moreover the international aspect of the energy market should not be neglected. Trading partners from third countries will be allowed access to the single large market provided of course due reciprocity is maintained or obtained.[4]

3. Plan of action

The Commission Working Document, 'The internal energy market' sets out the real and potential obstacles to the realization of the large single market in energy. These are detailed in a set of five annexes to the basic document, one for each of the principal energy sources (solid fuels, oil, natural gas, electricity and nuclear energy). Earlier in the document a strategy for action is established through which these obstacles will be progressively eliminated. The strategy may be broken down into four separate but interrelated sets of actions. A few words on each of these is in order.

The first concerns implementation of the energy-related provisions contained in the Commission's 'White Paper' of 1985 referred to above. Included in this particular framework are the harmonization of rules and technical norms, the approximation of fiscality (VAT and excise duty) and the opening up of public procurement to EC-wide competition in the energy sector. On this latter item, the Commission has recently published its proposals, [5] while, for taxation, proposals were sent to the Council in mid-1987.

The second set of actions concerns existing Community law and the need to apply it more strictly in the energy sector than has been the case hitherto. Essentially this will mean more assured free circulation of energy goods and services and the reinforcement of the rules of competition between enterprises. In addition it will lead to tighter discipline in applying Community rules on State aid and a detailed examina-

1 This article by Mr Maniatopoulos, Director-General of DG XVII, originally appeared in *AGIP Review* No 2, November 1988.
2 COM(85) 310 final.
3 COM(88) 238 final.
4 As was made clear at the European Council in Rhodes in December, the internal market will be a decisive factor contributing to greater liberalization in international trade on the basis of the GATT principles of reciprocal and mutually advantageous arrangements.
5 Com (88) 376, 377, 378.

tion of the exclusive rights which exist in many parts of the energy sector.

The third area arises from the Single European Act concerning higher levels of environmental protection. It is essential that policy solutions are found which provide a better balance between energy and the environment. This will undoubtedly be one of the principal issues in energy policy as a whole over the next few years. The Commission is committed to prepare a proposal on energy and environment which is likely to be ready in 1989.

The final framework for action presented in the report addresses those obstacles which are specific to the energy sector. Identified as requiring special attention are the issues of energy prices, and the need to strengthen energy infrastructures. The last point will be of special interest to Member States on the periphery of the Community.

4. Two points to watch

Energy is a commodity of immense strategic importance. To appreciate this, we only have to recall the oil price shocks of the 1970s and the threat they posed to our economy, and indeed to our whole way of life. Moreover, the European Community is dependent for 45% of total energy consumed on imported energy supplies. This dependence on imports will increase over the long term as indigenous energy resources decline. In this situation, security of supply is of paramount importance.

Energy will always therefore be of prime importance to governments whether at national level or the European Community. It would not be realistic, or indeed desirable, to allow market forces alone to determine developments in a sector of such strategic importance as energy. A balance must be struck between intervention by governments or Community on the one hand, and market forces on the other. The Community's energy objectives for 1995 provide just such a balance.

In the context of the internal energy market, the Commission will evaluate very carefully the effects of measures to open up the Community energy market on security of supply. Continued security of supply is not an 'optional extra'. It must remain a condition of an integrated, barrier-free single energy market.

The Single European Act provides for the need to maintain social and economic cohesion within the Community, in particular to reduce disparities between regions and the backwardness of the least-favoured regions. In drawing up proposals for the internal energy market, the Commission must take the regional question into account and propose measures to promote economic and social cohesion. For example, proposals to integrate further energy infrastructures in the Community will tend to benefit most the isolated, peripheral parts of the Community. The decision taken at the European Council meeting in Brussels in February 1988 to double structural Funds (regional, social and agricultural guidance funds) over the next few years will undoubtedly help in this context. The Commission is currently looking at ways and means of channelling some of these funds into energy projects in the less advantaged regions of the Community.

5. The future

Energy Ministers gave their first reaction to the proposals contained in the 'Internal energy market' document at the Energy Council meeting in Luxembourg on 9 June 1988. Their initial response was positive with a clear welcome given to the paper. It is not unreasonable to expect, however, many months and even some years of hard discussion and negotiation in the Council as proposals are brought forward by the Commission to remove specific obstacles. It will be a challenging task. While the object is clear, the removal of barriers to the large single European energy market, the Commission must take into account, when formulating proposals, the need to maintain security of supply and to reinforce social and economic cohesion within the Community. Indeed the Commission will also have to take into account differences between the energy situations of individual Member States, for example, differences in climate, geographic situation and indigenous energy resources.

Work is already underway to develop the analysis contained in the working document. Studies are being undertaken, research carried out and working groups formed, together with the necessary consultation with Member States and the industries concerned. In the field of the application of Community law, for example, work within the Commission is already underway which may lead before too long to actions by the Commission, using its autonomous powers, in the energy sector. The next major stepping stone will be a progress report on developments to be prepared by the Commission before the end of 1989.

6. Conclusion

The momentum towards completing the internal market is irreversible. It is inconceivable that energy, so essential to the economic and social well-being of the Community, should not play a major role in its achievement. The Commission and Member States over the coming months and years thus have a duty to ensure that the internal energy market becomes a reality and the citizens of the Community are able to benefit from its realization.

Note

Since this article was written, the internal energy market has been discussed at an informal meeting of Community Energy Ministers in Athens on 24 September 1988 and again in Brussels on 8 November. At the latter meeting, the Council drew some first conclusions regarding the importance of the internal energy market to the achievement of the single large market of 1992 and the benefits which will accrue to consumers, industry, Member States and the Community as a whole. The full text of the Council's conclusions is published in the following pages.

Internal energy market — Council conclusions

The Council had a detailed discussion on establishing the internal energy market. The starting-point for the discussion was the Commission document entitled 'The internal energy market'[1] and work done at the Council as a follow-up to the Council meeting on 9 June 1988.

As it had already done at its meeting on 9 June 1988 and at the informal meeting of the Energy Ministers in Athens on 24 September 1988, the Council stressed the importance of the Commission working document and it was noted that that document represented a major contribution to the attainment of an internal energy market. The Council also agreed with the overall approach proposed by the Commission, which advocates making parallel progress in the different spheres of action in order to establish the internal energy market.

In the light of its discussions, the Council arrived at the following conclusions:

(1) The internal energy market should contribute to establishing the large market of 1992 and to strengthening the achievements of the Community energy policy. It should also help to strengthen the competitiveness of the European economy and the development of the Community.

(2) The creation of an internal energy market:

(i) should have beneficial consequences for consumers in the Community and for the competitiveness of its industries;

(ii) should also be an important factor in the Community's security of energy supplies;

(iii) should pave the way for increased trade in energy between Member States;

(iv) should enhance solidarity between the Member States;

(v) should improve the ability of undertakings to adapt and develop.

It will also be important to assess the effects which the creation of an internal energy market is likely to have on external relations in the energy sector.

(3) The achievement of a satisfactory balance between energy and the environment — in accordance with the Single Act — must constitute a major goal of the Community's work, and the Council accordingly welcomed the Commission's intention of considering this field in greater detail and of preparing a coherent programme as soon as possible.

(4) The internal energy market also depends on the development of efficient energy infrastructures. In efforts to achieve this development, account must be taken of the objective of economic and social cohesion as defined in the Single Act, as well as of the specific characteristics of various regions, notably those at the periphery of the Community. Efforts in that direction must be supported by available Community financing instruments.

(5) The development and dissemination of new energy technologies is of capital importance in reducing the Community's energy dependence. Stress was again laid on the importance of the programmes already under way, on which an evaluation report was shortly expected from the Commission.

(6) Bearing in mind the scale of the work which is to be carried through, the Council expressed its determination at its forthcoming meetings on energy questions to pay particular attention to these matters, including those which did not come exclusively within the energy sector but were of major importance to it.

(7) Finally, the Council took note of the information provided by the Commission on the continuation of work and in particular the Commission's intention of working out a plan of action as soon as possible and submitting a progress report before the end of 1989 as well as specific reports and proposals on individual sectors.[2] The Commission was also requested to brief the Council regularly on progress with regard to the internal energy market.

The information submitted by the Commission comprises the following main points:

(i) **end of 1988-beginning of 1989:** proposals on the transparency of energy prices for major consumers of gas and electricity;

(ii) **mid-1989:** systematic overall report on energy and the environment;

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1 COM(88) 238 final.

2 See following lists of topics covered.

(iii) **during 1989:**
- (a) action to remove barriers to transfrontier trade in electricity;
- (b) report on the advantage of common carrier systems for increasing trade in gas and electricity;

(iv) **end of 1989:**
- (a) report on the problems involved in energy infrastructures;
- (b) overall report on progress with regard to the internal energy market.

The oil market and the refining industries in the Community: recent developments and prospects to 1995

On 21 September the Commission approved a communication entitled 'The oil market and the refining industry in the Community: recent developments and the prospects until 1995'. This is the latest in a series of reports on the progress made in combating the problems which have beset the refining industry in the Community over the last 10 years, namely:

(i) the large surplus of primary distillation capacity and the excessive number of refining sites;

(ii) the need to invest in conversion capacity to boost production of lighter products and improve product quality.

Both these problems stem from the decline in consumption since 1979, combined with the increase in net imports of finished products from non-Community countries and in relative demand for light products and, more recently, the tightening-up of environmental protection standards.

The solution was seen to lie in concentration of the industry's activities at a much reduced number of more complex refineries.

As a result, primary distillation capacity in the Community has steadily been cut back from 920 million tonnes a year (Mt/year) in 1980 to 592 Mt/year in January 1988, or by 36% in eight years.

This reduction inside the Community mirrors the capacity shedding worldwide. Over the same period refining capacity fell by 14% in the USA and by 16% in Japan.

This drive within the Community brought the average utilization rate in 1987 to close to 80%, the minimum for efficient operation of refining plants. With demand on refineries expected to hold steady or increase slightly if prices remain in the USD 15-20 a barrel range, the refining balance for the Community as a whole is better than at any time since 1980.

Despite this improvement, the industry still faces serious structural problems, particularly:

(a) imbalances between countries and regions where capacity is well tuned to demand and those where overcapacity and poor utilization rates persist;

(b) potential major discrepancies between the compliance costs borne by the industry in Member States with differing environmental standards;

(c) low profitability, even where refineries are heavily used, making it more difficult to justify and finance investments.

Table 1 — Refining capacity in the Community: Refinery structure 1980-88

Number and capacity of simple, semi-complex and complex refineries (on 1 Jan.)

Type of refinery	1980			1988		
	No	Primary capacity		No	Primary capacity	
		Mt	%		Mt	%
Simple	62	249	27	16	43	7
Semi-complex	24	148	16	20	89	15
Complex	55	523	57	58	460	78
Total of which:	141	920	100	94	592	100
Refineries over 1 Mt/year	129	915		90	590	

Definitions:
Simple refinery : Primary distillation plus reforming and hydrodesulphurization.
Semi-complex refinery : 'Simple refinery' plus visbreaking unit and thermal cracker.
Complex refinery : 'Simple' or 'semi-complex' refinery plus catalytic cracker, hydrocracker or coking unit.
Source: Commission of the European Communities.

What does the future hold in store up to 1995?

Three main factors determine the situation in the European refining industry: consumption trends, import trends and refining capacity.

Consumption trends

Medium-term oil consumption trends in the Community will depend in turn on a series of factors, notably:

(i) economic and industrial growth rates;

(ii) the progress made towards more rational use of energy;

(iii) oil prices and inter-fuel competition.

The Commission studied two price scenarios to assess potential problems up to 1995: a 'low price' (USD 15-20 a barrel) and a 'high price' scenario (USD 25-30 a barrel).

In the high price scenario, after the 1986-88 increase total oil consumption would slip back again to around the 1985 total of 485 Mt by 1995. In the low price scenario the recent upswing in oil consumption would continue up to 520 Mt by 1995.

Table 2 — EUR 12: Projections for 1995: principal assumptions

	High oil price scenario	Low oil price scenario
GDP growth	Average 2.6% a year between 1985 and 1995 giving growth of 29% over 10 years	
Oil price (in 1988 dollars)	Return to USD 25-30 per barrel in 1989 and holding steady until 1995	Fluctuating between USD 15 and 20 a barrel (towards the top end of the range in 1995)
Total oil consumption in 1995	485 Mt	520 Mt

The two scenarios both assume the same GDP growth and agree with the Member States consumption forecasts. As already stated the Member States forecast oil consumption in 1995 at 501 Mtoe, in the middle of the range suggested by the two scenarios.

In the high oil price scenario total oil consumption would slip back again after the 1986-88 increase to return to around the 1985 total of 485 Mt by 1995. The breakdown of consumption by product category would however change between 1985 and 1995, with a 20 million tonnes increase in consumption of petrol kerosene and diesel fuel in transport being offset by a similar fall in heating oil consumption in homes and heavy fuel oil consumption in industry.

In the low oil price scenario the recent upward trend in oil consumption would continue to total around 520 Mt in 1995.

Oil product import trends

For years the Community has allowed non-Community oil products free access to its market.

The Community's balance of trade in oil products in 1987 was as follows:

(i) gross imports: 164 Mt (as in 1986);

(ii) gross exports: 137 Mt (5% down on 1986);

(iii) balance: net imports of 27 Mt.

Nothing in the data available suggests any significant increase in oil imports from non-Community countries over the next few years.

Instead, the liberalization of international trade, combined with the growing demand in non-Community countries, particularly in oil-producing regions which have recently brought into service new refining capacity geared to the export market, and the trend for the producing countries to invest in the downstream branches of the oil industry in the Community could all encourage exports of crude oil rather than of refined products.

Refining balance

Based on the scenarios described above, the following developments could be expected between 1987 and 1995:

(i) oil consumption would drop by 17 million tonnes in the high price scenario but increase by 18 million tonnes in the low price scenario;

(ii) net imports of finished products from non-Community countries would hold steady at today's level;

(iii) the volume refined would drop by 15 million tonnes in the high price scenario but rise by 20 million tonnes in the low price scenario;

(iv) according to the oil companies, primary capacity would fall by almost 20 million tonnes;

Table 3 — EUR 10/EUR 12 - Overall pattern of oil finished products external trade

(in mio t)

	EUR 10					EUR 12		
	1981	1982	1983	1984	1985	1986	1987 First estimates	Variations 1987/86
Total imports of finished products[1]	122.5	138.7	136.0	145.8	145.3	163.3	164	+ 0.4
Total exports of finished products[1]	115.5	117.4	120.5	116.6	115.7	144.4	137	— 5
Net imports (exports) of finished products	7.0	21.3	15.5	29.2	29.6	18.9	27	+ 43

Source: Cronos (national statistics) — Feedstocks excluded.
[1] Intra-Community trade included.

Table 4 — Refining in the Community: overall balance, 1980-95

In millions of tonnes per annum	1980	1985	1986	1987	1995 Scenario 25-30$/b	1995 Scenario 15-20$/b
Total oil consumption of which:	577	486	502	502	485	520
● inland deliveries	510	430	441	442	430	455
● international bunkers	29	27	31	30	27	34
● refinery consumption	37	29	30	30	28	31
Net supplies of finished petroleum products of which:	7	33	21	30	30	30
● net imports from non-Community countries	12	24	19	27	25	25
● Primary sources[1]	2	5	5	5	5	5
● Drawn from stock	—5	4	—3	—1	—	—
Refinery throughput:						
● Crude oil (including condensates)	545	408	437	428	410	445
● Total (including all feedstocks[2]	570	453	481	472	455	490
Primary distillation capacity (on 1 January)	920	663	619	595	575	575
Utilization capacity in relation to:						
● crude oil processed	59%	62%	71%	72%	71%	77%
● total throughput	62%	68%	78%	79%	79%	85%

Source: Commission of the European Communities.
[1] Directly usable associated materials including by-products from the production of natural gas.
[2] Assumption for feedstocks in the Netherlands: 5 Mt/year from 1985.

(v) the utilization rate for primary capacity would remain at the current 79% in the high price scenario but rise to 85% in the low price scenario.

For the Community refining industry the high price scenario would, therefore, mean continuation of the status quo with gross overcapacity of some 20%. In the low price scenario gross spare primary capacity would be trimmed back to about 15% by 1995.

Whatever the scenario, primary refining capacity will therefore continue to exceed total oil consumption in the Community, leaving the industry with more than enough capacity to satisfy demand.

However, the refining industry remains in the shadow of a persistent worldwide surplus equivalent to one quarter of all installed primary capacity. This surplus refining capacity in a market with ample supplies of crude oil will continue to depress the profitability of refining operations both inside and outside the Community.

Six other factors will influence the restructuring of the European refining industry.

They are:

1. **Pattern of consumption**

Electricity consumption is increasing steadily in its specific applications. Natural gas too is gaining ground as the grid is extended.

A far bigger increase in natural gas's share could be expected if environmental protection legislation were to become so strict that oil products in general, and heavy fuel oil in particular, were forced off the market.

At the same time the pattern of consumption of oil products will depend on the price scenarios suggested by the Commission. As can be seen from Table 5, extra conversion capacity will be needed if the low price scenario proves true.

Table 5 — Oil consumption in the Community Medium-term prospects for EUR 12

In millions of tonnes	1980	1985	1995 Scenario 25-30$/bl	1995 Scenario 15-20$/bl
1. Inland deliveries	510	430	430	455
● Petrol	91	91	95	100
● Kerosene	21	22	24	26
● Automotive gas oil	52	62	76	81
● Heating gas oil	120	100	89	99
● Heavy fuel oil	156	78	70	70
● Other products	71	77	76	79
2. Bunkers, of which:	29	27	27	34
● Gas oil	6	7	7	7
● Heavy fuel oil	23	19	19	26
3. Refinery fuel, of which:	37	29	28	31
● Heavy fuel oil	18	11	10	13
4. Total consumption (1+2+3)	576	486	485	520

Sources: Eurostat and OECD.
Commission scenarios.

2. **Regional imbalances**

Although the refining balance for the Community as a whole is better than at any time since 1980, with an average utilization rate close to 80 %, imbalances remain between various Member States, some of whom have managed to adjust their capacity to demand while others have not.

For example, the utilization rate was well above the Community average in Germany, Denmark and Greece and slightly above in Belgium, Spain, the Netherlands and the United Kingdom but well below in France, Italy, Portugal and Ireland.

The geographical breakdown shows that in the north of the Community (Belgium, Germany, Denmark, the Netherlands and the United Kingdom) 82% of primary capacity is used at a rate of 80% or more whereas in the south (Spain, France, Italy, Greece and Portugal) only 37% is, confirmation that the proportion of surplus capacity is far higher in the southern Member States.

All the oil companies consulted agreed that it will be far harder to close down refineries in the future. Refiners are reluctant to resort to closures because of the problems associated with job losses, particularly in regions with high unemployment, and because of the heavy cost of mothballing installations, which is virtually impossible to estimate.

Table 6 — Refining capacity in the Community: primary capacity utilization rates

%	1985 min.	1985 max.	1986 min.	1986 max.	1987 min.	1987 max.
Belgique	47	58	71	80		83
Danmark	81	87	88	96		91
BR Deutschland	68	81	81	94		92
Ellas	68	68	84	91		93
España	67	69	79	81		78
France	63	69	61	66		71
Ireland	43	44	52	53		53
Italia	51	57	61	66		66
Luxembourg	—	—	—	—	—	—
Nederland	58	65	76	84		86
Portugal	49	50	58	59		54
United Kingdom	72	78	75	84		91
EUR 12	62	68	71	78	72	79

NB: The actual utilization rate lies between:
(i) A minimum rate indicating the ratio of crude oil processed in the refinery to the primary capacity at the beginning of the year; and
(ii) a maximum rate indicating the ratio of the total quantities (crude and feedstocks) processed in the refinery and the primary capacity at the beginning of the year.
(Assumption for feedstocks processed in the Netherlands: 5 Mt/year from 1985).
Source: Commission of the European Communities.

3. Environmental protection costs

The June 1986 study by Chem Systems on behalf of the Commission concluded that differences between the national environmental standards in force in 1993 would create substantial discrepancies between the compliance costs borne by refiners in different Member States. The conclusions of this study and their implications for intra-Community trade were discussed with the oil companies at a series of meetings in early 1988.

Despite the differences in, for example, distribution, capital or labour costs from one Member State to another, any increasing disparity in the cost of compliance with environmental protection standards could still affect intra-Community trade to a certain extent and companies' decisions about the location of investments and disinvestments. Greater approximation of standards throughout the Community over a reasonable period therefore seems highly desirable.

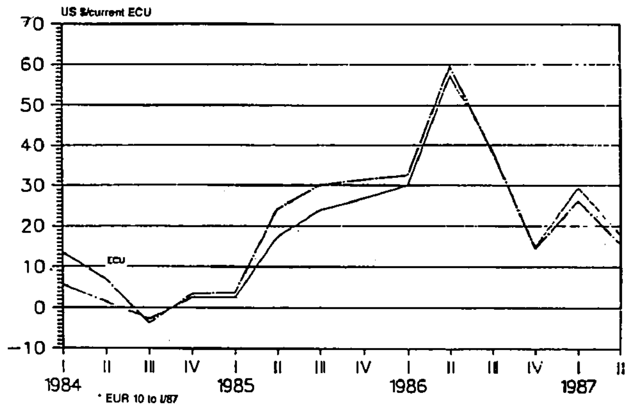
4. Profitability of refining

While the capacity utilization rate remains the surest sign of the state of health of the refining industry in Europe, the profitability side must not be overlooked.

Revenue on the refined products market has been inadequate compared with crude oil supply costs, narrowing the refining margin or even making it negative. This is basically a symptom of the oversupply on the world oil market. It is felt particularly acutely by companies concentrating primarily on refining, with no crude oil production of their own and no specialized downstream activities (such as petrochemicals or lubricants).

The following graph shows that margins in the Community have fluctuated widely but have remained inadequate since the mid-1970s.

Refining gross margins — marge brute de raffinage
EUR 12*



Source: Informations reçues par la commission en application des directives 'Transparence'.
Information recieved by the Commission of the European Communities with the application of the Transparency Directives.

Under these circumstances, companies' strategic choices, and in particular their degree of upstream and downstream integration and the geographical distribution of their markets, assume decisive importance.

5. Investments in downstream activities in Europe by oil-producing countries

For some years certain oil-producing countries have been acquiring refining and/or distribution assets in the Community. At the moment such investments account for 3.5% of refining capacity in the Community.

The Commission considers these investments constructive provided the companies operate on a long-term basis following the same rules as their competitors, particularly against the background of the continuing rationalization of the European refining industry and diversification of sources of supply.

The Cooperation Agreement concluded on 15 June 1988 between the Community and the Gulf Cooperation Council countries should encourage closer economic cooperation between the two sides. The energy clauses of this Agreement provide for in-depth analyses of trade in oil between the two regions and of their implications for industry in general and refining in particular.

The Commission believes that this industrial cooperation should focus on areas in which the two sides complement each other and take account of the interests of oil companies in the Community and the GCC in the upstream and downstream branches of the oil industry in the two regions. The industry must be closely involved in implementing the Cooperation Agreement, since successful attainment of its objectives will depend heavily on industry's voluntary cooperation.

6. **Completion of the internal market in 1992**

In a recent report to the Council the Commission listed the obstacles to completion of the internal energy market. [1]

Completion of the single market accompanied by the disappearance of frontiers within the Community will in any case end certain protected positions (monopolies and other restrictive practices). This will boost competition between oil producers in the same or different Member States and narrow the gaps between pre-tax prices for oil products.

Tax harmonization in turn will make for more uniform conditions of competition between fuels on the markets in the individual Member States, sharply reducing Member States' margin of manoeuvres for adjusting individual tax rates.

Conclusions and recommendations

Against this background, the Commission tabled the following recommendations at the Council meeting on 8 November 1988:

1. The policies previously adopted regarding domestic refining and import of petroleum products should be continued but with greater emphasis on the regional situation.

2. Rationalization should continue, concentrating on areas and refineries where utilization rates are below viable levels.

3. In the interests of security of supply and international competitiveness, the Community should maintain an efficient and viable refining industry operating at high utilization rates but with a margin of spare capacity to meet unforeseen increases in demand.

4. The Community should maintain its open attitude to imports of petroleum products and to downstream investments by oil producing countries provided similar policies are pursued by other major oil consuming and oil exporting countries and that the viability of the Community industry and its restructuring are not adversely affected.

5. The Community should make every effort to reduce differences in environmental standards in the various Member States which could significantly affect the industry's costs.

6. The responsibility for restructuring should, as hitherto, be left to the companies, provided security of supply and free competition are not impaired.

7. Governments should, however, assume an active role in the measures taken by the industry.

The Commission hopes that implementation of these recommendations will bring about further improvements in the situation of the refining industry in the Community.

It will continue to monitor developments and, if no progress is made in the refining industry in the Community, to report to the Council as necessary on the action to be taken.

[1] COM(88) 238 final, 2 May 1988.

More privately generated electricity — a way to save primary energy

Eking out the primary energy base continues to receive a high priority in Community energy policy. Electricity forms an ever-increasing part of the Community's final energy consumption. The logical outcome is for particularly rational use to be made of (non-renewable) energy resources, and this has long been the practice among public electricity supply undertakings (ESUs), in the interests of their own competitiveness.

However, there is also potential outside the public supply sector for generating electricity in ways which save resources. These involve the use of production methods which are highly dependent on local conditions or specific industrial processes, and are thus less suitable for the ESUs large power plants than for private generation by industrial or other private power station operators.

But the public supply undertakings are also in a position to play an important part in promoting this sector. This idea lies at the heart of the proposal for a Council recommendation to the Member States to promote cooperation between public electricity supply companies and private generators of electricity, which the Commission sent the Council on 4 May 1988. [1]

What types of private generation are involved?

The recommendation covers three categories of power generation, namely electricity generated:

(i) from renewable sources of energy, i.e.

. solar energy
. biomass
. geothermal energy
. wind energy
. energy from the sea
. hydropower, above all in small plants;

(ii) through the exploitation of waste energy, i.e.

. combustion of waste
. residual heat in industry;

(iii) through combined heat and power (CHP).

All these forms of energy have in common the fact that, owing to the potential contribution which they can make to primary energy saving, they accord with the objectives of Community energy policy. However, they form a very mixed package in that they offer highly variable prospects of profitability.

The most important criterion for them to be of practical use will still, of course, be future price trends for the exhaustible primary energy sources, especially oil. But there are other factors involved. Thus photovoltaic electricity generation can already hold its own in particular supply niches in the Community, such as in remote mountain cottages or light-buoys in the sea. But for this to account for a growing share of electricity supply would imply considerably longer production runs, and this would in turn imply a far greater market penetration. Another example: for CHP plants to be profitable, many factors in addition to energy/price relationships may be decisive, such as the coincidence of heat and energy requirements, technical improvements in district heat transmission and in the CHP process in small plants, density and quality of buildings, structure of industry, etc. These many uncertainties justify the broad scope of the recommendation as shown above, in the interests of spreading the risk.

Necessity and problems of cooperation

While the task of the ESUs is exclusively to supply others with electricity, private electricity producers do so chiefly to cover their own needs. However, these do not always simultaneously correspond to their own production, so that plants can only operate cost-effectively if surplus power can be fed into the public grid and/or additional power drawn from it. Reserve capacity is also required for times when their plant is shut down.

For these reasons the private generator is generally forced into close cooperation with the ESU; but this dependency does not necessarily always provide the advantages which it objectively could. Apart from the attitude of the ESU, laws or administrative regulations can have a limiting effect on private generation. If electricity generation is to be developed more strongly on the basis mentioned here — renewable energy, waste energy and CHP (these are abbreviated to RWC in the recommendation) — such obstacles must be removed. They have a negative effect on both the quantities and prices of privately generated electricity.

From the point of view of quantity, it is first of all a question of whether private generation is possible at all; it is generally

[1] COM(88) 225 final. (The recommendation has now been published in OJ L 335, 7.12.1988, p. 29.)

allowed, but this does not everywhere have a statutory basis or even one of formal agreements between the parties involved. Capacity limits, which are fixed by law for private generation in some countries, sometimes for each energy source, have directly limiting effects. Finally, there are also varying rules on feeding surplus power into the grid, ranging from a general statutory obligation to accept it to cases where it is entirely within the discretion of the ESU to refuse to buy surplus power altogether.

So far as prices are concerned, the rates paid for surplus electricity supplied to the public network are always geared to the costs avoided by public supply companies. In a regulatory framework whose chief aims are the protection of territory and legal supply commitments on the part of the ESUs, this may well be the right approach. For if the private supplier were to have *his* costs reimbursed, the ESU would then have additional costs, if, in the case of irregular supplies to the grid, it still had to maintain its own generating capacity. Where these additional costs were not covered by general subsidies, they would either have to be borne by the ESU or the consumer would have to pay them as part of the price of electricity, thus subsidizing the private generator.

In practice, however, the problem is that this 'costs avoided' principle is not applied in a satisfactory way. Relationships are also very variable here. On the one hand there are rules which provide for full reimbursement, i.e. including fixed costs, in the form of a capacity allowance. This is partly based on the calculation that, while the individual private supplier may not necessarily be able to guarantee regular supplies, where there is a sufficient mixture of different forms of privately supplied electricity (e.g. wind energy, hydropower, etc.) the ESU should always have a certain degree of private generation capacity at its disposal in a particular supply area, which could justify its dispensing with investments in generating capacity and possibly in the network. On the other hand, prices paid for private electricity supplied are sometimes even lower than the fuel costs avoided.

Against this background, the purpose of the Commission proposal is to provide all private producers of 'RWC' electricity with the unhindered opportunity to do so, fair access to the public grid and reasonable prices for the power they supply to the grid. What is involved, then, is simply for existing obstacles to the further development of this type of private generation, which makes the most effective contribution towards the goal of the rational use of energy by saving exhaustible primary energy, to be removed without giving it a privileged position, for instance by subsidizing it through electricity prices. If such privilieges were regarded as necessary, however, special measures would have to be considered.

Principal features of the recommendation

1. The Member States should set up a framework for cooperation between ESUs and private producers who generate power based on renewable energy source, waste energy and combined heat and power (RWC), under which the conditions concerning the quantity and price of electricity exchange are agreed in accordance with common principles. This framework must provide both parties with sufficient reliable data for them to make investment and operational decisions.
2. The framework conditions, in the form of standard contract criteria, may be fixed either by voluntary agreements between the parties concerned or through legal or administrative provisions. The need for a specific arbitration procedure should also be determined.
3. So long as private generation does not encroach on any public interest, it should be made possible and not impeded by either administrative provisions or contractual conditions.
4. The ESUs should be obliged to accept surplus electricity from RWC production, provided that the economic operation of their existing plant is not thereby jeopardized.
5. Reimbursement for power supplied to the network should be based primarily on the long-term average costs which can be avoided in the public electricity supply system. These are:
   (i) at least the variable costs, i.e. mainly fuel costs;
   (ii) also fixed investment or purchase costs, in so far as these are actually avoided in the public supply system as a result of the private power supplied. The size of this fixed-cost component of the reimbursement should depend on how regularly the private supplier's generation capacity is available.
6. When drawing additonal power from the public grid, a private producer should be treated in the same way as a comparable customer without private generation capacity.

State of deliberations

The Council held an initial exchange of opinions on this proposal at its meeting on 9 June 1988. Under the usual consultation procedure for the Council's final decision, Parliament approved the proposal on 7 July 1988, and the Economic and Social Committee is preparing an opinion.

A Community action programme for improving the efficiency of electricity use

Communication from the Commission to the Council and proposed Council Decision

In a Communication to the Council, the Commission set out an action programme for improving the efficiency of electricity use and attached a proposal for a Council Decision on the subject. Following the November Energy Council, the Communication and proposal were sent to the European Parliament and the Economic and Social Committee. The Council also requested that the document be studied in its own working groups in advance of the next Council on energy questions. These discussions have started. The full text of the Communication including a summary of the proposed Council Decision is reproduced below.

I. Introduction

1. The importance of energy saving to the Community economy has been frequently emphasized by the Council. In its Resolution of 16 September 1986 [1] the Council called for a vigorous policy for energy saving and adopted the objective of achieving at least a further 20% improvement in the efficiency of final energy demand by 1995. Towards achieving this objective, this Communication proposes a Council Decision which would establish a Community action programme to improve the efficiency of electricity use.

2. The Commission, in its Communication to the Council in October 1987 (COM(87) 496 final), presented the case for a concerted programme of action throughout the Community to exploit the potential for improved efficiency in the use of electricity. The Council recognized the importance of this and invited the Commission to associate electricity distributors with this exercise, as well as other interested parties.

3. The Commission has since held discussions with interested parties represented at Community level, including electricity utilities, energy consumer organizations, energy managers and manufacturers in the lighting, electric motor, and domestic appliance fields. All parties indicated their willingness to cooperate in a Community action programme, and endorsed its objectives.

4. The Community action programme concentrates on improving the efficiency of final electricity use and does not deal, for example, with measures such as improvements in the efficiency of electricity production or load management, both of which can improve the economics of electricity supply. Questions of correct pricing and, particularly, the use of appropriate tariff structures are also vital for encouraging the efficient use of electricity but will be addressed elsewhere in the internal energy market context.

II. Reasons for promoting the more efficient use of electricity

5. Electricity consumption, which grew at about 3% a year during the 1980s, now accounts for about 17% of final energy demand in the Community. The increasing role of electricity often reflects the introduction of more efficient and productive technologies, contributing to industrial competitivity and higher standards of living. Electricity is also the vector through which solid fuels and nuclear power have greatly reduced the Community's dependence on imported oil, and will in future be the main vector through which renewable energies can contribute to Community energy supply. The growing role of electricity does, therefore, make it all the more important to ensure its efficient use.

6. Savings in electricity correspond to still greater savings in primary energy demand. In 1987, the electricity consumption of 1 570 TWh[2] required the input of 367 Mtoe[3] of primary energy (35% of total primary energy consumption). If electricity use in 1987 had been 5% less (78.5 TWh, equal to 6.75 Mtoe final energy use), this would have reduced the requirement for primary fuels for electricity consumption by 18.4 Mtoe, some 2.7 times as much, due to the gearing effect of transformation losses.

7. Recent estimates indicate that, if 90% of equipment and appliances used in the Community in 1985 had been the most efficient commercially available, there

[1] OJ C 241, 25.9.1986, p. 1.
[2] TWh = KWh x 10^9.
[3] Mtoe = Millions of tonnes oil equivalent.

would have been considerable savings in electricity consumption. Electricity consumption in the industrial sector could have been lower by some 11%, in the residential sector by 20%, in the tertiary sector by 11% and in the transport sector by 3%, resulting in an overall reduction in consumption of some 12%. These estimates, although approximate, indicate that significant savings are possible by improvements in the inherent efficiency of electrical equipment.

8. Reductions in electricity consumption bring other benefits. It is estimated that a 10% improvement in the efficiency of electricity use could, by the year 2000, avoid the need for some 40 GW of additional generating plant with a reduction in investment requirements of some ECU 35-40 milliard. This would imply consequential reductions in costs to electricity consumers. Since a high proportion of such additional plant would use fossil fuels, the considerable reduction in atmospheric emissions would contribute to the reduction of environmental pollution.

9. A Community action programme in this field would be complementary to other existing Community actions. Not least of these is the Community energy demonstration project programme, which has a high energy-saving content. Other actions include the Council Directive on the energy labelling of domestic appliances [4] and the Commission initiative on the energy certification of buildings.[5]

III. Areas of potential efficiency improvements

10. In the **domestic sector** there have been significant improvements in the electrical efficiency of new appliances over the years. Typically, over the last 10 years the specific electricity consumption of refrigerators has reduced by at least 16%, that of dishwashers by at least 10% and that of washing machines by at least 26%. In lighting, also, new types of fluorescent lamps offer saving potentials of 70% to 80% compared with incandescent lamps. Savings can also be achieved by the more controlled use of electrical space and water heating.

11. In the **industrial sector**, motive power accounts for some 60% of total consumption. In this area significant savings are possible by the correct choice of electric motor size, by the replacement of existing motors by higher efficiency motors, by the correct choice of the type of regulation of the driven pump or fan and by suitable automatic control to ensure the minimum necessary running time. The use of electricity for process heat accounts for a further 20% of consumption. Here the choice of the most efficient process and the reduction of waste heat are further areas of saving potential. Lighting is also used extensively in industry; both the choice of the types of lighting equipment used and the use of automatic controls to minimize consumption are potential areas of saving.

12. The principal areas of application in the **tertiary sector** are space and water heating, motive power and lighting. As in the other sectors, the potential of savings lies in the selection of the most efficient equipment and the careful control of its use. Although this is a heterogeneous sector, it does include public and office buildings, areas in which considerable potential for savings in both lighting and heating is known to exist.

IV. Objectives of Community action

13. To achieve the potential savings from improving the efficiency of electricity use and the resultant benefits, Community action should have two principle objectives.

14. Consumer behaviour must be influenced in favour of the use of the most efficient electrical appliances and equipment and of using these in the most efficient manner.

The improvement of the overall efficiency of electricity use does not depend just on improving the efficiency of industrial equipment and domestic appliances, important as this is. It depends at least as much on the electricity consumer, to whom costs and cost-effectiveness are important. The extent of his awareness of efficiency and costs will determine whether he purchases and installs the most efficient models available. Community action, to be effective, must cover all these aspects.

15. All consumers should be well informed on the relative efficiencies of equipment commercially available, its cost-effectiveness and its efficient use. Furthermore, they should have ready access to technical advice on the purchase and installation of the most efficient equipment. In many cases the user of electrical equipment

[4] OJ L 145, 13.6.1979, p. 1.
[5] OJ C 267, 6.10.1987, p. 2.

(the electricity consumer) is not responsible for the choice of equipment, which has been specified by an architect, in the case of buildings, or a consulting engineer. Those responsible for specifying electrical equipment must be sensitized to the importance of efficiency and well informed on the relative efficiencies of available equipment.

16. The efficiency of electrical appliances, equipment, and electricity-based processes should be further improved and high-efficiency equipment effectively marketed.

High-efficiency equipment should be effectively marketed and efforts made to increase the proportion of such equipment in commercial use, including the transfer of technology throughout the Community. Where the lack of technical harmonization or standardization (whether performance standards or equipment standards) hinders improvement in the efficiency of electricity use, corrective measures must be taken. The promotion of new, high-efficiency equipment by demonstration projects and the replication of such projects should be used to increase the overall efficiency of equipment and its use. Research and development should also continue with the aim of bringing forward into commercial use even more efficient electrical equipment.

V. Participants in Community action

17. The above objectives can best be furthered by the coordinated efforts of a number of different organizations and institutions. This would ensure that the benefits of experience, technical and marketing expertise were harnessed together throughout the Community. The Community action programme should therefore involve the following:

(i) *electricity distributors*, who have both a high level of expertise in the use of electricity and the closest and the most direct relationship with the final consumer;

(ii) *consumer organizations*, who are already active in providing information to consumers both on the relative efficiencies and costs of various appliances and equipment, principally in the domestic sector;

(iii) *professional institutions* in both engineering and architectural fields, who have a role to play in ensuring that the concept of the efficient use of electricity is thoroughly understood and put into practice by those responsible for the specification of equipment;

(iv) *manufacturers* of electrical appliances and equipment, through their representative organizations, can also make a valuable contribution. Collective action on their part can contribute towards improving the efficiency of electrical appliances and equipment on the market;

(v) *Member State governments*, who can take a lead by ensuring the exemplary efficient use of electricity in the premises which they own or occupy. In addition, efforts should be particularly focused on electricity use within Member States energy saving programmes;

(vi) *the Commission*, which has a coordinating and supporting role to play in the planning and execution of Community action.

VI. The Community action programme

Elements of the programme

18. The Community action programme would be set in hand by the proposed Council Decision. The implementation of the programme must provide sufficient flexibility to ensure maximum effectiveness in each Member State. The programme would include the following elements:

(a) *Consumer information*: Improvements in the information available to consumers and equipment specifiers, on appliance and equipment efficiency and efficient use, should be made through:

(i) electricity distributors, who should develop action programmes to this end;

(ii) consumer organizations, who should further improve their dissemination of information through all appropriate media;

(iii) the appliance and equipment manufacturers, who should ensure not only the availability of adequate information but also its specific relevance to electrical efficiency;

(iv) Member State governments and the Commission should ensure that their activities in this area include measures to inform consumers;

(v) the Commission, electricity distributors and manufacturers should cooperate in the establishment of appropriate databases.

(b) *Technical advice*: Technical advice on the purchase, installation and use of the most efficient appliances and equipment should be readily available to consumers, especially those lacking technical expertise in this field. This involves:

(i) electricity distributors, who may themselves provide such advice or have information available on where such advice can be obtained (e.g. third-party financing companies, energy service companies, consulting engineers, etc.);

(ii) consumer organizations;

(iii) professional institutions, who should ensure that adequate educational facilities exist in areas concerned with the efficient use of electricity;

(iv) Member State governments should ensure that, where appropriate, their consumer information activities include information on sources of technical advice.

(c) *Appliance and equipment efficiencies*: Actions should be taken not only to improve the efficiency of appliances and equipment but to increase the market share of the most efficient models already commercially available. To these ends:

(i) manufacturers of appliances and equipment should, by collaboration through their associations, take actions to improve equipment and appliance efficiencies. They should intensify their own marketing efforts in electrically efficient equipment and their support for the marketing efforts of other parties;

(ii) electricity distributors should make the increased penetration of more electrically efficient appliances and equipment a major element of their action programmes in this area, including examination of the potential of selective financial intervention;

(iii) Member State governments and all other parties directly involved with the execution of the Community programme should take actions to ensure that, in all the activities for which they are responsible and in all the buildings they own or occupy, electrical appliances and equipment are of high efficiency and efficiently operated;

(iv) all parties should facilitate the transfer of high-efficiency technology in the Community;

(v) new or improved efficiency-related standards, which experience elsewhere has shown can be an effective means of energy saving, should be introduced wherever appropriate.

(d) *Financial incentives*: The massive use of financial incentives to achieve improved efficiency in electricity use is obviously not a desirable option. Nevertheless, there may be situations where financial incentives have advantages. It may, for example, be beneficial for electricity distributors to give support to activities which, through the selective reduction of electricity use, produce savings in the costs of electricity supply. Although not strictly a financial incentive, the use of the third-party financing technique can facilitate and encourage investments to achieve improved efficiency of electricity use.

(e) *Demonstration and R&D*: Demonstration of new, electrically efficient appliances, equipment and technologies should be supported and coordinated between national and Community programmes and the results disseminated throughout the Community.

(f) *Programme coordination and monitoring*: The Commission would be responsible for the coordination of the planning and implementation of the programme, and monitoring of results. It would encourage the setting of practical targets for efficiency improvement and reasonable timetables for their achievement, provide financial support for studies, databases, seminars and other information activities. It should inform the Council regularly on the development and the results of the programme.

Management of the programme

19. Underlying the Community pattern of electricity consumption are differing patterns in the Member States. Such differences, and the reasons for them, should be taken into account in determining the most effective actions to be taken. Thus, it is important that the manage-

ment of the Community action programme should be sufficiently flexible to ensure that actions within individual Member States are appropriate to their needs and circumstances. At the same time, coordination and support as well as monitoring of the actions and their results should be provided at Community level.

20. To achieve this, the draft Council Decision proposes that:

(i) Member State governments should establish national bodies, responsible for the implementation and coordination, at national level, of actions within the Community action programme. All interested parties should be represented in these bodies, including the electricity utilities, electrical equipment manufacturers, consumers' organizations and appropriate professional bodies;

(ii) a Community Action Programme Advisory Committee should be established to assist the Commission in the coordination of the action programme and to advise on appropriate activities to be carried out at Community level in support of the action programme. All national bodies should be represented on this Committee, which should call on other interested parties as appropriate;

(iii) a Community Action Programme Secretariat should be established by the Commission, responsible for coordination, dissemination of information, management of studies or other actions at Community level and the preparation of regular progress reports to the Council.

Copies of the proposed Council Decision can be obtained by writing to the Editor.

Federal Republic of Germany

The Federal Republic of Germany has the highest population of the Member States of the European Community with over 61 million inhabitants (19% of the EC total).

The area of the country is 249 000 km^2 giving a density of population of 245 persons per km^2 — the third highest in the Community (after the Netherlands and Belgium).

The main conurbation is in the Rhine-Ruhr area where nearly 8 million people are concentrated in 17 towns, the suburbs of which merge to form a vast and more or less continuous urban area. The working population exceeds 25 million (20.6% of EC total) of which around 38% are women. About 8% of the civilian labour force is unemployed.

During the 1970s, GDP growth, at constant market prices, averaged 2.7%. There was very little growth in 1981 and negative growth in 1982. Recovery in 1983 (to 1.5%) was followed in the years 1984-86 by growth of around 2.6-2.7% per annum falling back to below 2% in 1987.

In 1987 the gross domestic product (GDP) was in the order of DM 2 009 billion (ECU 970 billion) which was forecast to increase to a little below DM 2 100 billion in 1988 (over ECU 1 000 billion). This is 40% above the GDP per head of population in the Community. In spite of continuing rises in the value of the German mark against, in particular, the US dollar (USD), the current account trade surplus remained positive in recent years standing at around 3.7% of GDP in 1987. Germany's official reserves (gross) are by far the highest in the Community at ECU 84 billion being 29% of the EC total. Short-term interest rates are the lowest in the Community (around 5%).

The Federal Republic of Germany is the largest energy consumer in Western Europe and the third largest among the industrial nations with a gross energy consumption of around 270 Mtoe (25% of EC total). The share of oil in this energy consumption is 42%. Germany depends heavily on imported energy (close to 60%).

Developments in the energy market

Recent decades have witnessed important structural changes in federal Germany's energy supply. Coal, the dominant energy source in the 1950s, was replaced by oil in the 1960s. In 1960, coal accounted for 75% of primary energy demand while the share of oil was only 21%. However, between that date and the first oil crisis in 1973, coal's share had slipped to 31% while oil's share had risen to 55%. With the declining role of domestically produced hard coal and the increasing importance of oil, dependence on imported energy resources increased drastically during the 1960s.

Since the two oil price crises, changing modes of behaviour on the part of industry and consumers have helped to reduce the dependence on oil substantially:

(i) consumption of oil was brought down from 55% in 1973 to 42% in 1987; the dependence on imports is about 60% for energy in general and about 97% for oil;

(ii) OPEC's market share has been reduced from 96% in 1973 to less than 50%;

(iii) the share of North Sea oil in total oil supply is now just under 40%.

Structural adjustment of the West German economy towards more efficient use of energy resources has had a positive impact. From a peak in 1979, total energy consumption decreased 8% by 1984 thus returning back to the 1973 level. It remains near this level in spite of a GDP increase of more than 30% in the last 15 years. In spite of the fall of international energy prices since 1986, the specific energy consumption declined by 2% in 1986 and by 1.6% in 1987. The German consumer benefited from the drastic fall in crude oil prices as the Federal Government allowed this to be passed on. However, the trend towards reducing oil consumption and increased substitution and conservation was not seriously affected. There was some increase in 1986 but this was partly caused by stock additions and was followed by a decrease in 1987.

Electricity consumption has increased since 1982 and amounted in 1986 to 413 TWh (increase of 0.6% in comparison with 1985). Natural gas and oil as fuels for electricity production have continued to lose importance although some consumption increases occurred in 1986. At present the combined share of hydrocarbons in electricity production is around 10%. Solid fuels and nuclear on the other hand represent about 87% of fuel input.

Finally, on the question of the environment, there have been a number of advances including strict emission standards for all combustion plants, exhaust fume controlled cars, unleaded petrol and increasing use of low polluting forms of energy such as natural gas and nuclear power.

The summarized energy balances for the years 1973, 1980, 1982 and 1987 are given in Table 1 together with forecasts for 1990 and 1995.

Table 1 — Summarized energy balance — Federal Republic of Germany December 1988

Million toe	1973 A	1980 A	1982 A	1987 A	1990 B	1995 B
Gross energy consumption	265.79	273.12	251.45	269.47	286.4	281.7
— Bunkers	3.58	2.85	2.70	2.86	2.9	2.9
— Inland consumption	262.21	270.27	248.75	266.61	283.5	278.8
Inland energy consumption	262.21	270.27	248.75	266.61	283.5	278.8
— Solid fuels	83.16	82.70	81.60	75.01	78.8	79.8
— Oil	146.21	128.86	109.32	111.09	121.5	116.0
— Gas	26.99	44.69	38.30	45.48	47.4	47.0
— Primary electricity etc.	5.85	14.02	19.53	35.03	35.8	36.0
Indigenous production[1]	119.18	121.53	124.81	127.68	126.7	121.8
— Hard coal	69.13	62.19	63.20	54.36	52.0	49.0
— Lignite & peat	22.92	26.50	25.77	21.04	24.0	24.0
— Oil	7.14	4.97	4.42	4.77	2.8	0.7
— Natural gas	15.02	14.35	12.47	12.80	13.0	13.0
— Nuclear energy	3.05	11.06	16.52	31.89	33.3	33.5
— Hydro & geothermal[2]	1.20	1.49	1.54	1.59	1.6	1.6
— Others & renewables	0.72	0.97	0.89	1.23		
Net imports[3]	147.41	156.99	130.09	144.51	159.7	159.9
— Solid fuels	−10.15	− 5.34	− 0.36	0.68	2.8	6.8
— Oil	144.65	131.25	104.05	110.46	121.6	118.2
— Natural gas	12.03	30.58	25.82	33.05	34.4	34.0
— Electricity[2]	0.88	0.50	0.58	0.32	0.9	0.9
Stock changes[4]	0.81	5.40	3.45	2.72		
— Solid fuels	−1.27	0.65	7.01	1.07		
— Oil	2.01	4.51	− 3.55	1.28		
— Gas	0.07	0.24	0.01	0.37		
Electr. generation input	69.50	85.14	85.15	95.02	98.6	105.1
— Solid fuels[5]	47.02	52.62	54.00	50.64	54.6	57.9
— Oil	9.75	5.64	3.94	3.27	3.2	5.2
— Natural gas	7.76	13.36	8.26	6.40	5.9	6.9
— Nuclear energy	3.05	11.06	16.52	31.89	33.3	33.5
— Hydro & geothermal	1.20	1.49	1.54	1.59	1.6	1.6
— Others & renewables[2]	0.72	0.97	0.89	1.23		

Main indicators (related to long-term objectives)

	1973-63	1980-73	1987-82	1990-87	1995-90
Inland energy annual growth rate	4.3%	0.4%	1.4%	2.1%	− 0.3%
GDP annual growth rate	4.5%	2.2%	2.1%	2.8%	2.5%
Improvement in energy intensity					

	1973	1980	1982	1987	1990	1995
Share of oil in gross energy consumption	56.4%	48.2%	44.5%	42.3%	43.4%	42.2%
Share of hydrocarbons in electricity production	25.2%	22.3%	14.3%	10.2%	9.2%	11.5%
Supply dependance on imports	55.5%	57.5%	51.7%	53.6%	55.8%	56.8%

Sources: A. Statistical Office of the European Communities.
B. Submissions from Member States and best estimates from external sources.

Notes: 1. Production of primary sources including recovered products.
2. The conversion of electricity, including hydro and geothermal, is based on its actual energy content: 3 600 kJ/kWh or 860 kcal/kWh.
3. The (—) sign means net exports.
4. The (—) sign means a stock decrease.
5. Including coke oven gas and blast furnace gas (derived from coal).

General notes:
Figures submitted by Member States have been adapted where necessary to ensure consistency with SOEC statistical definitions or conversion factors.

The present situation

Oil

The share of oil in primary energy consumption has fallen from 55% in 1973 to the present figure of 42%. This is the result of sharp increases in the price of oil and of the policy of reducing dependence on oil. None the less, oil remains the single most important energy source and in certain areas (transport and chemical industry) it is irreplaceable.

There have been considerable changes in the oil import structure. The most important single source of supply is now the North Sea, providing more than 30% of oil imports. Dependence on OPEC oil has fallen from the former 95% to below 50% in 1988.

Competition and free pricing are the main steering mechanisms on the oil market. An important condition for this is the unrestricted access to the German market for crude oil and petroleum products. This serves to integrate the German oil market fully into the world market. With an import dependence of 97%, this is a basic prerequisite for the smooth flow of supplies.

The German oil market is characterized by a large variety of different operators. Unlike most other major consumer countries, strong independent enterprises both on the import and on the marketing side have been established. The share of imported products in the total supply of products has always been high by international standards. In 1986 the share of imported oil products reached 43%, mostly from other Community Member States.

The refining industry consists of the major international companies (over half the capacity), followed by a number of German companies with small capacities (contributing 30%), the independent international enterprises (Conoco, Marathon) and other European companies (Elf, CFP, Agip, Petrofina). All refining companies purchase products at home and abroad. They also supply a certain part of the independents' product needs.

Refinery capacity decreased from 155 million t in 1978 to 85 million t in 1987. This decrease of capacity (50%) is the highest among all European countries (average EC: 35%).

The German refinery industry has coped with the structural change needed without help from the Federal Government.

The present relaxed supply situation results in keen competition especially on the thermal market. Mainly affected thereby is the German mineral oil industry, not least because of international distortions of competition. The Federal Government is making special efforts to reduce distortions of competition at the EC level by requesting harmonization of environmental standards and eliminating national protection in the form of price regulations and quantitative restrictions on imports.

Electricity

Domestic production of electricity is based on hard coal and lignite (together 53%), nuclear energy (31.5%), natural gas (7%) and hydropower. In keeping with energy policy objectives, oil accounts for a share of only slightly over 3%. Lignite and nuclear energy are employed for baseload generation owing to their cost advantages while hard coal is used chiefly in the intermediate load range. In 1987 there was an installed capacity of 95.8 GWe net which produced 393 TWh net during that year. This capacity is expected to rise to 101 GWe net by 1990.

The workhorse and the racer. Here the workhorse is the nuclear plant at Brunsbüttel (foreground) which produces the baseload electricity while the racer (background) is the gas turbine used for producing peak load electricity when required. The nuclear plant takes several hours to reach full power while the gas turbine only minutes.

Photo: Siemens

Electricity supplies are not provided by a single State-owned company, as is the case in many Western European countries, but by a number of different companies. Among them, the group of so-called public electricity suppliers has the largest share. The most important companies at the interregional level are the so-called grid companies (such as RWE, VEW, Bayernwerk, PREAG), which together exercise a decisive influence in electricity supply. They control the high-voltage grid as well as the major part of generating capacity (approximately 85%). They supply electricity directly or indirectly to most industrial users and final consumers (largely through regional or local distributors).

On the whole, more than 1 000 companies are active in public electricity supply. They are pluralistic and heterogeneous, both in terms of their areas of activity and in their organization and ownership structures. Most of them are in the hands of local authorities.

In addition, electricity is produced by industrial generators and the federal railways for their own needs. Some excess production of industrial power companies is supplied to the public grid.

Coal

Because of poor price competitiveness coal production in the federal Republic has slowed down from 110 million tonnes in 1970 to 75 million tonnes in 1987. At 265 DM/t, the steam coal price is in 1988 almost three times as high as the price of imported steam coal.

The main site of hard coal production is in the Ruhr district. Additional mining sites are located in the Saarland and Aachen areas. The largest hard coal mining company, Ruhrkohle AG, operates nearly all of the pits in the Ruhr district. Ruhrkohle AG was established during the coal crisis at the end of the 1960s as a unified company for the Ruhr area by means of considerable government support. Stakes in the company are held by private enterprises (mainly companies in the iron and steel and electric power industries).

The main users of German hard coal are the electric power industry (some 40 million tonnes) and the iron and steel industry (approximately 30 million tonnes). Sales to the electricity industry have been guaranteed by long-term agreement through to the year 1995 and are additionally regulated by the Law on the Use of Coal in Power Generation. The agreement provides for sales to increase up to 45 million tonnes per year. Sales have been guaranteed by means of a special levy, the so-called 'coal levy', to be paid by all the electric power users as a surcharge on electricity prices. The levy provides the power industry with the funds to cover the additional costs of using domestic coal.

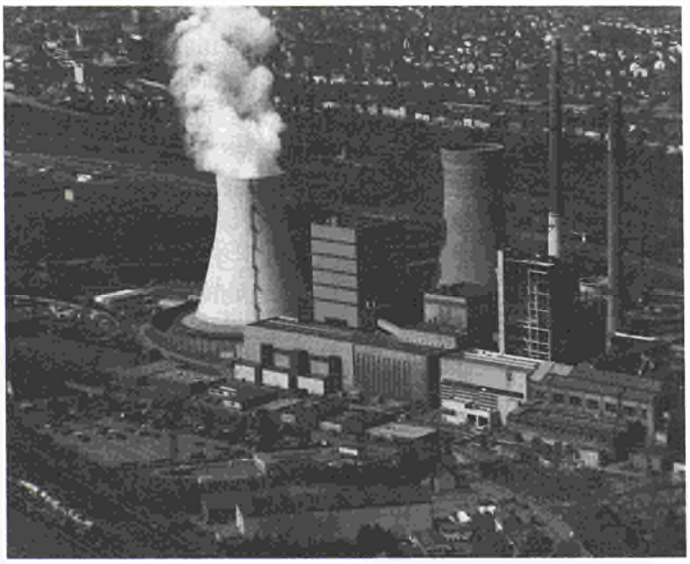
Because of the oil price fall, which has caused a general energy price drop worldwide, and of the lower dollar rate, the German mining industry's need for subsidies has visibly increased (1986: some DM 6 billion; 1987: some DM 10 billion). Owing to the negative trend in the steel industry, sales prospects do not look very rosy at the moment. For this reason, the decision was made in December 1987 to cut the output of coal by between 13 million and 15 million tonnes with resulting social hardships to be mitigated by redundancy schemes.

The economic situation of German lignite fields is, in contrast to hard coal mining, quite comfortable. Lignite is mostly mined in the Rhine-area (more than 100 Mio t per year) and used for electricity production.

Nuclear energy

The share of nuclear energy in total electricity output was 23% in 1984 and has increased to over 30% at present (its share in primary energy consumption is 11%). The nuclear share in public electricity supply is 36.6%.

Twenty producing reactors (20.225 MW net) and three research reactors (33 MW net) are in operation. A further two large reactors (2.481 MW) and a fast breeder prototype (311 MW) are currently under construction. The latter, SNR 300, is nearing completion, although the problems over its licensing in North-Rhine/Westphalia have remained unsolved.



The district heating plant of Völklingen in Saarland which is on schedule for completion in autumn 1989. When finished, this high-efficiency modern plant will produce 210 MW of electrical energy for Saarbrücken and 185 MW of district heat which will be used in Saarbrücken and Völklingen.

Photo: Siemens

Through the Atomic Energy Act, facilities for safe nuclear waste disposal are a prerequisite for the construction of nuclear power stations. Waste disposal is carried out on the basis of an integrated disposal scheme enacted in 1979 jointly by the Federal and the *Länder* governments. It provides for all steps necessary for disposal to be carried out in Germany. In this context, reprocessing is also included and has priority over other disposal techniques.

In February 1985 it was decided to build the reprocessing plant at Wackersdorf. This facility will have a nominal capacity of 350 tonnes of heavy metal per year. Construction started in December 1985; the commissioning has been envisaged for 1995. Disposal techniques such as direct final storage are being studied. This storage would be carried out in salt domes.

Gas

The share of gas in primary energy consumption in 1987 was nearly 17% (over 45 Mtoe). The Federal Government pays attention to having a balanced gas import structure. At present, domestic production stands at nearly 28%. West European sources of supply (the Netherlands, Norway) account for some 43% and the USSR for 29%. Gas supplies from the Soviet Union will rise till 1990, but not exceed 30% of the total German gas needs. Long-term import contracts provide for a secure and balanced natural gas supply situation beyond the year 2000.

Germany has become one of the world's largest natural gas importers and the German gas industry is an important partner in the European natural gas market (participating in international purchasing consortia, transmission of border-crossing supplies).

The industry is characterized by a three-tier structure:

(1) the seven producers of domestic natural gas sell their output to 15 regional or national pipeline companies;

(2) these 15 companies acquire gas both from domestic producers as well as through imports. They provide gas to the local gas utilities and to large users. The Ruhrgas company has by far the most important market position;

(3) approximately 500 regional and local gas utilities supply final consumers on a local level, with the exception of individual large-scale clients who are directly supplied by the long-distance gas companies. Gas prices are

set by competitive forces. There are no government rates. Contracts with large-scale purchasers are subject to anti-trust control, just as in the case of electricity.

Renewable sources of energy

Renewable sources of energy such as solar, wind energy, biomass, geothermal energy as well as hydropower are to render a major contribution to energy supply in the long term. However, their share (excluding hydropower) is still under 1% of primary energy consumption. Scientific institutes and industry concur that renewable energy is in a position to render a growing, but limited contribution to energy supply — 4-7% of primary energy consumption — because of the unfavourable climatic conditions in this country.

The Federal Government advocates keeping open this option in spite of the currently not favourable prospects and affirmed this position in responding to a very long Parliamentary questionnaire recently.

The Federal Government promotes these sources of energy:

(i) through extensive assistance to R&D in this field;

(ii) within the framework of development assistance;

(iii) through EC demonstration programmes, investment grants and tax deductions.

The R,D&D programme on renewables mainly focuses on the further development of wind and solar energy. The total R,D&D budget amounted to ECU 40 million in 1986 and ECU 61 million in 1987.

Energy policy

The Federal Republic of Germany is the largest energy consumer in Western Europe and the third largest among the industrial nations. However, its energy intensity is about 10% less than the European average and even two-thirds less than the average for the industrial nations as a whole.

This positive achievement has been brought about mainly because the energy policy is oriented as far as possible along free market principles, the free decisions of investors and consumers facilitated, and government influence kept to a minimum.

The policy aims at:

(i) conservation and rational use of energy,

(ii) ensuring supplies at internationally competitive terms,

and

(iii) having the least possible impact on the environment.

Energy policy, too, is oriented towards:

(iv) diversification of energy sources and of geographical areas of energy supply, an energy policy objective, which is agreed upon in the European Community and which is dictated by the high share of 60% of imported energy;

(v) good relations with the *Länder* (this is particularly important in the problem areas of coal and nuclear energy);

(vi) research, development and demonstration in the field of energy technologies.

The Federal Government's energy policy was laid down last in its September 1986 Energy Report.

Current energy policy issues

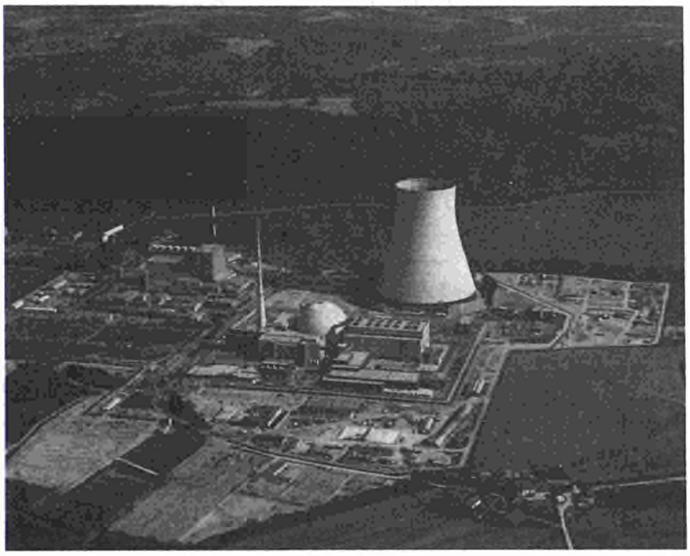
Nuclear energy

The role of nuclear energy is one of the main energy policy issues since the 1970s. It is an area of considerable concern since the Chernobyl accident. The resistance against the use of nuclear energy further strengthened after the so-called Transnuklear affair, which showed irregularities in the transportation of nuclear radioactive waste (see *Energy in Europe* Nos 10 and 11 and this issue). The two opposition parties in the Bundestag (the first chamber of the German Parliament), the SPD (Social-Democratic Party) and the Greens are advocating the phasing-out of the nuclear energy, which accounts now for more than 30% of electricity generation in the Federal Republic of Germany (and 37% in the EC). The Federal Government has reiterated its position for continued use of nuclear energy in the Jahreswirtschaftsbericht 1988 (Economic Report of 1988). It has declared on several occasions that:

(i) the use of nuclear energy is justified in view of the high safety standards obligatory for nuclear power stations in Germany, and

(ii) that there are no better alternatives available in the foreseeable future from the point of view of energy security, competitive prices and of ecological reasons given the low level of SO_2, NO_x and CO_2 emissions of nuclear plants.

This statement takes into account that full use is made of the potential of energy conservation and renewable sources of energy.



The nuclear power stations Isar 1 and Isar 2.
Photo: Siemens

The Federal Government's view is that any short-term abandonment of nuclear power would endanger electricity supply, although theoretical capacity calculations would permit such an abandonment in the long term. However, the economic price to be paid would be too high and politically unacceptable. International energy markets would undergo severe change if other large industrial nations waived the use of nuclear power. The consequences would be environmental pollution by sulphur dioxide, nitrogen oxide and dust emissions (causing damage to forests) as well as by carbon dioxide (changing the climate), because nuclear power would ultimately have to be replaced by coal-fired electricity production capacity. Moreover, energy supply would be less secure, the competitiveness of the German economy impaired and setbacks to growth and employment would be unavoidable.

Because of the different views concerning the use of nuclear energy, there is today a lack of consensus between the main political forces in the country on an important energy policy issue. This situation is shown clearly by the fast breeder reactor at Kalkar, a 300 MW-demonstration plant which is the major component of the German contribution to the joint European development of breeder reactors. The construction work of this plant is practically finished, but the licensing procedure is still going on, because the licensing authority, the Social-Democratic government of the *Land* North-Rhine/Westphalia, is refusing the last necessary licences.

In the field of safe nuclear waste disposal the Federal Government supports the construction of the reprocessing plant in Wackersdorf which is continuing. Waste disposal with reprocessing is today the only way to provide proof of adequate waste disposal that has been tested and can be approved under the Atomic Law. But direct final storage is being developed further with the support of the Federal Government as a supplement to waste disposal with reprocessing. The objective is to make this available as a technique by the mid-1990s.

Coal

The situation of the German hard coal industry is another issue for strong political concern. Because of unfavourable geological formations in which the coal must be mined, the industry is to a large extent non-competitive without State assistance. The costs of mining hard coal are considerably above world market prices. On the one hand hard coal is the major domestic energy source in Germany, on the other hand it receives considerable amounts of public subsidies in order to contribute to energy security as well as for reasons of labour markets and regional policy.

In 1987 hard coal demand by the iron and steel industry as well as in the heat market (industry and private households) continued to drop and will further decrease, whereas the subsidies amounted to more than 10 million DM/a. This is mainly due to the low coal world market prices and the dollar rates *vis-à-vis* the DM. Against this background the Federal Government, the governments of the coal-producing *Länder* North-Rhine/Westphalia and Saarland, the German Mining Companies as well as the Mining and Power Industries Trade Union discussed the difficult situation in the so-called Coal Round in December 1987. They took together some important decisions which will pave the way for a socially acceptable way of a further structural adjustment of hard coal production capacities in Germany.

(i) Since sales to the German and the European steel industries as well as to the heating market have been declining, it has become necessary to reduce domestic coal output. The reduction of capacity amounts to around 13 to 15 million tonnes.

(ii) Measures which will take account of social requirements will be implemented in the course of several years. The process should be completed by 1995 at the latest. The Federal Government and the *Länder* will provide further assistance to support this process. They assume that the enterprises will contribute an adequate share themselves.

(iii) It was generally agreed that German hard coal must continue to make a major contribution to the energy supply in the Federal Republic. This contribution is guaranteed by the Hüttenvertrag (agreement between coal sector and steel industry) and the electricity generation agreement. This agreement provides an input of German hard coal for electricity generation of more than 40 million tonnes per year up to 1995.

(iv) The Federal Government recently agreed that the coal pfennig (a levy on electricity consumption presently standing at 7.25 pfennigs) should be increased to 8.5 pfennigs. This should be voted on in the Parliament before the end of 1988. The quota structure of the century agreement is to be maintained until 1995. For the period after 1995 the participants of the Coal Round advocate an arrangement on the basis of the existing contractual regulations.

Environmental issues

The energy policy debate of the 1970s was dominated by the two oil price crises. Today, energy policy discussions are dominated by environmental issues. During the past years a comprehensive programme for clean air has come into effect: A totally revised Clean Air Regulation provides for stricter emission control standards for a great number of individual pollutants. It applies to all pollution sources of a certain size in all economic sectors and includes combustion plants between 1 and 50 MW of thermal output. Firing installations above 50 MW are covered by the 1983 Large Firing Installation Regulations, which provides severe emissions standards for NO_x, SO_2 and dust.

The Government recently adopted new environment standards for small combustion installations with a thermal capacity below 1 MW.

In order to reduce the environmental impact of energy use in the transport sector, the Federal Government continues to encourage the introduction of clean cars. For this purpose financial incentives are granted for clean cars. The price for unleaded petrol is lower than for leaded petrol due to tax advantages. The use of leaded regular petrol has been prohibited since February 1988, which caused a major shift of demand to unleaded fuel.

Internal market in the EEC

All member countries of the European Community have committed themselves to the completion of the internal European market in 1992 by the Single European Act. This commitment is of course valid for the energy sector too and will give a new impetus to a stronger exchange within the Community. The Commission of the European Communities recently published a basic document on this matter, which deals with all relevant questions concerning the internal market for energy and identified a lot of trade barriers (see *Energy in Europe* No 11, this issue and Special Issue). They will have to be abolished during the next years. Actions will be taken for example in the field of harmonization of energy taxes, public procurement in the energy sector, application of existing Community law concerning barriers to trade, subsidies, antitrust rules and harmonization of legislation.

Energy outlook to 1995

Up to 1995/2000 total primary energy requirements could remain nearly constant compared with 1987. However the following changes in the demand structure are expected:

(i) quantitative and percentage fall of oil demand in the German energy balance; despite the stimulus of low oil prices the share of oil should fall below 40% in 1995;

(ii) moderate increases in coal demand and stagnation of lignite consumption;

(iii) stagnation or moderate increase in natural gas consumption, possibly, up to 18% of primary energy requirements;

(iv) increasing share of nuclear in electricity generation in the short term, but at a lower growth rate than in the past;

(v) structural change in the economy, market penetration of new energy efficient technology and existing standards are expected to result in the long run in an autodynamic energy conservation process.

Expected energy demand up to 1995 should be covered by quasi-stagnant indigenous overall energy production and slightly growing net energy imports. Production up to 1995 would be characterized according to most recent scenarios by an increasing nuclear contribution, more or less stable gas and solid fuels shares and falling indigenous oil output.

Supply of uranium to the Community

Uranium is the fuel for the nuclear industry. The Community's nuclear power programmes therefore need a continuing supply of uranium. We do not produce anywhere near all the uranium that we need to fuel our reactors. Around three-quarters of the uranium burnt in the Community is imported. The main sources of uranium for import into the Community are Canada, Southern and Central Africa and Australia.

Once it has been extracted from its ore, uranium has to pass through several stages before it is ready to go into the nuclear reactors. For most types of reactors these further processing steps are conversion, enrichment and fabrication. However, for these areas of the fuel cycle the Community has either sufficient capacities — or plans to build such capacity — to cover its requirements at least until the end of the century.

The role of nuclear power in electricity supply

In 1987, nuclear power produced 32.4% of the electricity consumed in the European Community. This electricity was generated in six countries and some of it was exported to other countries within the Community.

Table 1 — Nuclear electricity production in EUR 12
Production (in THh x 10⁹) and nuclear share (%) of total

	1985	1986	1987
B	32.7 (60.3%)	37.3 (67.2%)	39.6 (66.0%)
D	119.5 (31.1%)	112.1 (29.4%)	123.2 (31.3%)
E	26.8 (22.2%)	35.9 (29.4%)	39.5 (31.2%)
F	213.1 (64.8%)	241.4 (69.7%)	251.3 (69.8%)
I	6.7 (3.8%)	8.4 (4.6%)	0.0 (0.0%)
NL	3.7 (6.1%)	4.0 (6.2%)	3.4 (5.2%)
UK	53.8 (19.4%)	51.8 (18.4%)	48.9 (17.5%)
EUR 12	456.1 (30.7%)	490.9 (32.3%)	506.0 (32.4%)

Source: Eurostat.

There are at present 132 nuclear reactors in the Community with a combined capacity of 94 GWe. A further 19 reactors (20.5 GWe) are under active construction and five more in Spain whose construction has either been temporarily halted (3 reactors) or 'deferred' (2 reactors). Most of the reactors under construction should enter service within the next five or six years.

The Community's uranium requirements

Each year, on average, a 1 000 MWe (1 GWe) pressurized water reactor (PWR) requires fuel made from around 150 tonnes of natural uranium. A boiling water reactor (BWR) requires a similar quantity while a gas-graphite (or Magnox) reactor requires closer to 230 tonnes/year. Nuclear reactors generally use more uranium during their first year or so of operation than in following years. A PWR, for example, requires over 300 tonnes of uranium for fabrication of its first core while a BWR requires closer to 500 tonnes and a gas-graphite reactor 900 tonnes for each GWe of operating capacity. In following years only a portion of the core is replaced at each refuelling.

In 1987 the fresh fuel inserted into the Community's reactors required 14 323 tonnes of natural uranium. While the installed nuclear capacity is expected to continue to grow, improvements in reactor design and techniques for saving uranium use (such as recycle of plutonium and uranium recovered from the reprocessing of spent fuel — see *Energy in Europe No 10*) are expected to limit increase in annual uranium requirements. The annual uranium requirements for the Community's nuclear programme are given in Table 2. The decrease between 1987 and 1990, while installed capacities are expected to be rising from 94 GWe to over 100 GWe, and the lack of increase between 1990 and 1995, while capacity will grow to close to 110 GWe, is caused partly by the above-mentioned uranium savings and partly by fewer reactors being in their first years of operation.

Table 2 — The Community's uranium requirements

Year	Annual requirement
1986	13 197 tonnes U
1987	14 323 tonnes U
1990	14 000 tonnes U[1]
1995	14 000 tonnes U[1]
2000	15 000 tonnes U[1]

Source: Euratom Supply Agency Annual Report (1987).
[1] Estimated.

Production of uranium in the Community

The annual production of uranium in the Community is around 3 700 tU. Five Member States produce uranium — France, Spain, Portugal, the Federal Republic of Germany and Belgium. France is by far the major producer with an annual production of over 3 250 tU per annum (tU/a). Spain produces a little over 220 tU/a and Portugal around 140 tU/a.

The 40 tU/a produced in Germany is from underground exploration (as opposed to industrial scale mining) while the 45 tU/a produced in Belgium all comes from the processing of imported phosphates.

France

In France there are six plants which produce uranium. Details of these are given in the following table. These plants extract uranium from ores mined from 15-20 different deposits, usually within the region in which the plants are located.

Table 3 — Uranium production centres in France

Name	Location	Annual capacity tU/a	Owner
L'Écarpière	Vendée	650	SIMO
Bessines	Haute-Vienne	1 500	SIMO
Le Cellier	Lozère	200	CFM
Bertholene	Aveyron	70	TCMF
Mailhac/Bernardan	Haute-Vienne	500	TCMF
Saint-Martin-du-Bosc	Hérault	900	SIMO

SIMO — Société industrielle des minerais de l'ouest — is a subsidiary of Cogema.

Cogema — Compagnie générale des matières nucléaires — is owned 100% by the Commissariat a l'Énergie Atomique (CEA).

CFM — Compagnie française de Mokta (a subsidiary of Cogema).

TCMF — Total Compagnie minière France is the mining operator of Total Compagnie française des pétroles (Total CFP) in France.

One other company — the Société nationale ELF Aquitaine/Production (SNEA/P) also has uranium mining interests in France.

The 70 000 tonnes of discovered uranium resources, recoverable at costs of up to USD 80/kgU (USD 30/lb U308), could support production at the present level for another 20-30 years. There are presently no plans to increase the annual rate of production.

Spain

In 1987 uranium production in Spain was around 220 tU. Nearly all of this uranium (200 t) was produced at the plant Saelices el Chico at Ciudad Rodrigo from ore mined from the Fe uranium deposit. The remainder came from the small experimental production plant (with a capacity of 30 tU/a) of La Haba at Don Benito.

The government agency Empresa Nacional del Uranio SA (Enusa) owns and operates the uranium production centres.

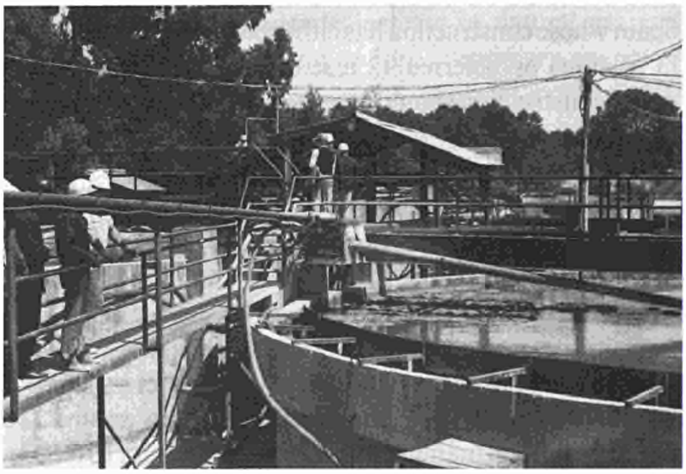
Already discovered resources in Spain which could be produced at costs of up to USD 80/kgU total over 28 000 tU. Most of these resources are located at or close to the Saelices el Chico production centre. It is planned to increase the capacity of this centre to around 800 tU/a by 1991.

Portugal

Uranium production in Portugal in 1987 was estimated to be around 140 tU. All the uranium was produced at the Urgeiriça plant using ore mined from several small deposits in the Beira Alta area. The capacity of the plant is 170 tU/a.

Plans have been made for the construction of a new production centre, Nisa, in the Alto Alentejo region. This plant, which will use ore from a number of deposits in the area, should have a capacity of 200 tU/a. The start-up date is planned for the early 1990s.

The public company Empresa Nacional de Uranio (ENU) is responsible for the production of uranium in Portugal. Any other company wishing to be involved in uranium exploration or mining in Portugal must first conclude an agreement with ENU.



Uranium extraction at the Urgeiriça Plant in Portugal.

Discovered uranium resources in Portugal, which could be recovered at USD 80/kgU or less, amount to 8 500 tonnes and are sufficient to support the expected production capacity of 370 tU/a for at least 20 years.

As Portugal does not have a nuclear power programme, it exports the uranium that it produces. Some is exported to other Member States.

Federal Republic of Germany

Uranium production in Germany is around 40 tU/a. This is produced by the plant at Ellweiler in Rheinland-Pfalz using ore from underground exploration activities at the Menzenschwand and Großschlopen uranium deposits.

The production capacity of the Ellweiler plant is 125 tU/a. The plant operates below this capacity because the supply of ore is limited. The company operating the plant is Gewerkschaft Brunhilde. The same company extracts the ore from the Menzenschwand deposit. Another company, Interuran (ex-Saarberg Interplan Uran) is actively exploring the Großschlopen deposit in Bavaria in a 50/50 joint venture with the British Civil Uranium Procurement Organization (BCUPO).

There are no plans to expand uranium production in Germany, though the Großschlopen deposit could support a 250 tU/a production facility.

Discovered resources recoverable at costs of up to USD 80/kgU are around 2 400 tU.

Belgium

Around 40 tU/a are produced in Belgium from imported phosphates. Belgium has no known uranium resources.

Table 4 — Uranium production capacities in the Community (tU/year)
(Based on resources recoverable at USD 80/kgU or less)

	1987[1]	1990		1995		2000	
		A	B	A	B	A	B
B	45	45	0	45	0	45	0
D	38	100	0	100	0	100	0
E	223	233	0	850	0	850	0
F	3 276	3 870	0	3 870	0	3 870	0
I	0	0	0	0	238	0	238
P	141	160	0	160	155	150	180
EUR 12	3 723	4 408	(0)	5 025	(393)	5 015	(418)

[1] Actual production.
Source: 'Uranium resources, production and demand' December 1987 Udpate (1988) — OECD(NEA).

In addition to those countries already producing uranium, two other Community Member States have economically exploitable uranium resources. Italy has reported 4 800 tonnes of uranium recoverable at USD 80/KgU (see above table for possible production rate) and Greece which has resources of around 6 400 tU. It appears unlikely that either country will produce significant quantities of uranium during the next decade.

The need to import uranium

While production capacity will increase during the 1990s to over 5 000 tU/year, it is considered unlikely that actual production will exceed 4 500 tonnes in any one year.

With annual requirements running at 14 000 tU or above, the utilities in the Community will need to supplement internal production by approximately 10 000 tU/year.

During the next few years, a part of this 10 000 tU could be covered by taking some uranium from existing stocks. However, by far the larger part will be met by importing uranium from outside the Community, especially while the market remains a relatively favourable one for the consumer.

The Community's external uranium suppliers

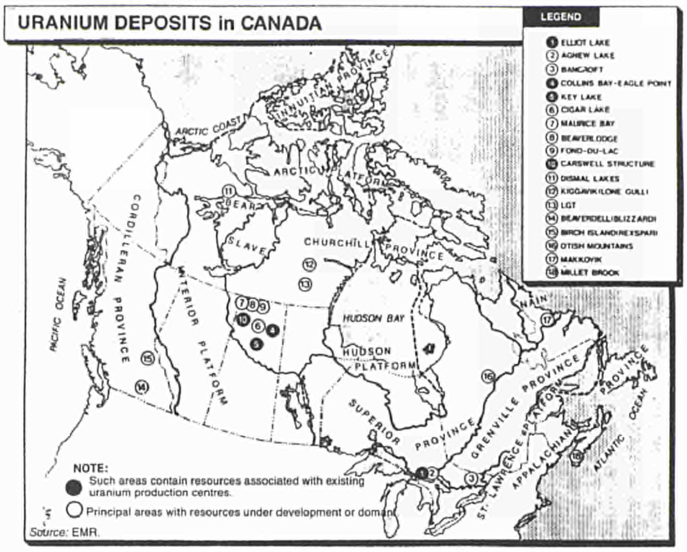
Uranium is imported into the Community from seven or eight countries: Canada, Niger, South Africa, Australia, Namibia, Gabon, China and the USA. According to the Euratom Supply Agency, no one country supplies more than 30% of the Community's total imports.

Canada

Canada is the world's largest uranium producer with an annual production of around 12 000 tU, about one third of the total western world's supply. Over 60% of Canada's production comes from three operations in northern Saskatchewan and the remainder from four centres in the Elliot Lake region of Ontario (see Figure 1).

The three centres in Saskatchewan are producing uranium from high or relatively high grade deposits. They are the Rabbit Lake plant processing ore from the Collins Bay 'B' deposit; the Cluff Lake facility, processing ore from the Claude and Dominique-Peter mines; and the Key Lake plant, processing ore from the Gaertner open pit. The latter is the largest single producer of uranium in the world with a nominal capacity of 4 600 tU/year which it has shown it is capable of exceeding.

Fig. 1 — Uranium deposits in Canada.



There are also many additional deposits in this area of Canada which have not yet been brought into production. Possibly the most important is the Cigar Lake deposit with estimated *in situ* resources of over 100 000 tU at an average grade of over 12% uranium and around 40 000 tU at a lower grade (4%). Production at a rate of 4 600 tU/year could start in 1994. Other important deposits in Saskatchewan include Eagle Point — which is along trend and northeast of the Collins Bay deposits — and the Midwest Lake deposit. The Kiggavik deposit, located in the Northwest Territories in a similar geological setting to the Saskatchewan deposits, contains over 14 000 tU and could be brought into production in the mid-1990s.

The uranium mines in the Elliot Lake area of Ontario (Rio Algom's Quirke, Panel and Stanleigh mines and Denison's mine) are all large tonnage, low-grade producers. There are no known plans to bring new mines into production in this area.

European companies — or companies with European parents — have considerable interests in Canadian production centres. The British company RTZ holds a 52.75% interest in Rio Algom Ltd. The German company Uranerzbergbau, through its subsidiary UEM, has a 33.3% interest in the Key Lake mine and Urangesellschaft is a 79% shareholder in the Kiggavik deposit. The French companies Cogema and Pechiney hold 80% of the Cluff Lake mine and the former also has an important interest (36%) in the Cigar Lake deposit.

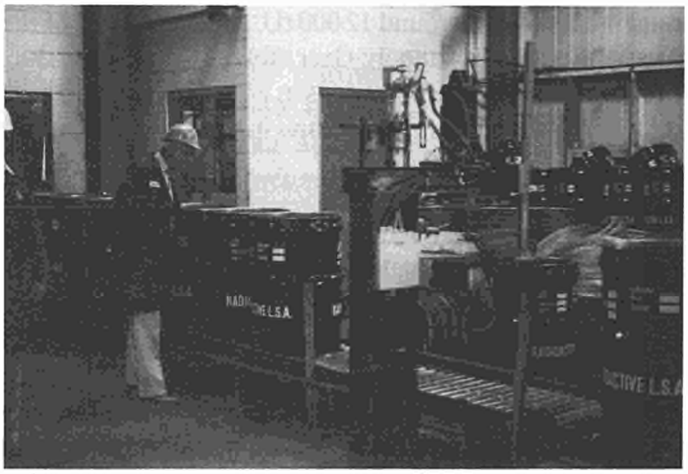
The recently announced agreement to merge and eventually privatize the Federal Government-owned Eldorado Nuclear Ltd (100% shareholder in the Collins Bay and Eagle Point South deposits and 33.3% shareholder in Key Lake) and the provincial government-owned Saskatchewan Mining Development Corporation (50% shareholder in Key Lake, 20% shareholder in Cluff Lake, 48.7% shareholder in Cigar Lake and a significant shareholder in most other major uranium projects in Saskatchewan) will create a uranium giant being directly responsible for nearly half of all Canada's uranium production for the foreseeable future.

Another recent event which could have a profound effect on uranium supply patterns is the signing of the US-Canada Free Trade Agreement. Under the terms of this agreement, the US 'would exempt Canada from any restriction on the

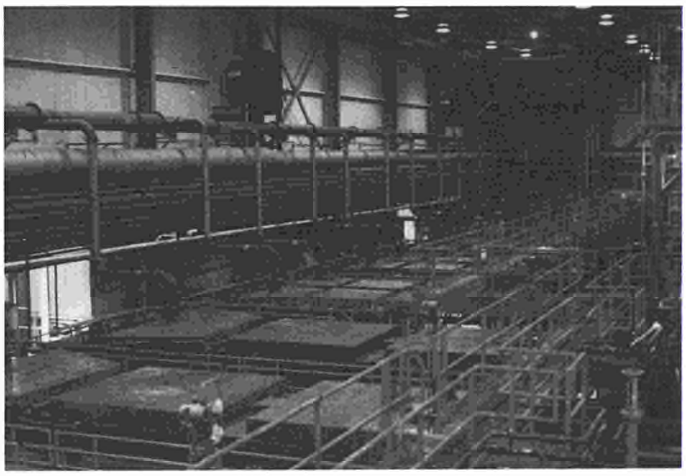
Table 5 — Expected changes in Canadian uranium production
Tonnes uranium per year

1988	1989	1990	1991	1992	1993	1994	1995	1996
11 900	12 070	12 270	12 270	12 270	13 270	14 570	16 870	16 870

Source: Nukem Market Report 3/88.



Loading 'yellowcake' into drums at Key Lake, Saskatchewan, Canada.



Counter current decantation (CCD) units in the Key Lake mill, Canada.

enrichment of foreign uranium under section 161v of the Atomic Energy Act'. If such restrictions are imposed — and if the Free Trade Agreement comes into force — Canada could well become the only foreign supplier of uranium to the US nuclear power programme.

As of 31 December 1987, Canada had discovered resources of 258 000 tU recoverable at costs of USD 80/KgU or less. Table 5 contains one possible scenario for the development of production from these resources over the next few years.

Niger

Uranium production in Niger in 1987 was expected to be around 3 000 tU. This means that Niger's two uranium production centres, at Arlit and Akouta, were together operating well below their combined capacity of 4 600 tU/year. Production has, in fact, decreased every year since the beginning of the 1980s.

Niger has sizeable uranium resources with over 450 000 tU recoverable at costs below USD 80/KgU. In addition to the two existing centres, the technical possibility of installing three new centres has been studied. These are Arni (with a production capacity of 2 000 tU/year), Imouraren (3 000 tU/year) and Afasto-Ouest (900-1 300 tU/year). There are presently no plans to install these new capacities.

The company operating the Arlit centre (Somair) has a substantial European interest (over 50% French and some German and Italian shareholding). French companies also have a one third interest in Cominak, the company operating the Akouta centre. Enusa (Spain) also has a holding in this company.

South Africa

In 1987 South Africa produced 3 950 tonnes of uranium, down over 600 tonnes from the 1986 production. This was the first time in 10 years that the annual production has fallen below 4 000 tonnes. However the decrease over the previous year was mainly due to work stoppages and production in 1988 is expected to increase to a little below the 1986 level.

There are 10 uranium producers, ranging from the largest (Vaal Reef) producing over 1 600 tonnes of uranium per year to the smallest (Loraine Gold Mines) with a production of only 5-10 tonnes per year. With only one exception, the uranium is produced as a co- or by-product of gold production from the Witwatersrand Basin conglomerates. The exception — Chemwes — is a mill recovering uranium from 'slimes', the material left over after gold has been removed from crushed rock. Therefore, while the uranium content of the rocks is generally low (much less than in the Saskatchewan and Australian mines) much of the cost of recovering it is covered by the gold production.

Of the 350 000 tonnes of uranium recoverable at costs of USD 80/KgU, over 300 000 tonnes occur in the conglomerates of the Witwatersrand Basin. The major part of future production of uranium from South Africa will therefore continue to be linked to the production of gold. There are several gold mines which have put their uranium recovery plants on a care and maintenance basis. These could be brought back into service if there was an increase in demand for uranium from South Africa. Together with possible new capacity, they could increase production in South Africa to 10-12 000 t/a and maintain this level well into the next century.

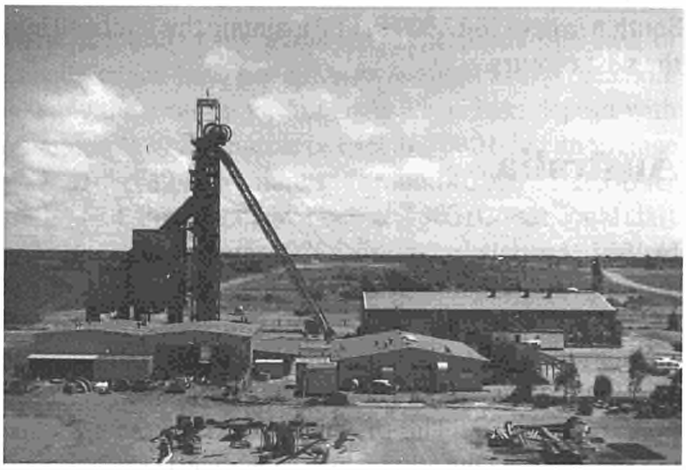
Australia

In 1987, Australia produced 3 780 tonnes of uranium. The majority of this came from the Ranger mine (capacity of 3 800 tU/a) with the balance from the Nabarlek project (capacity 1 270 tU/a). The uranium deposit at Nabarlek was all mined in 1979 and since that date production has been from stockpiled ore. This stockpile should be used up before the end of 1988. One other mine — Olympic Dam — started uranium production this year with a capacity of 1 700 tU/a.

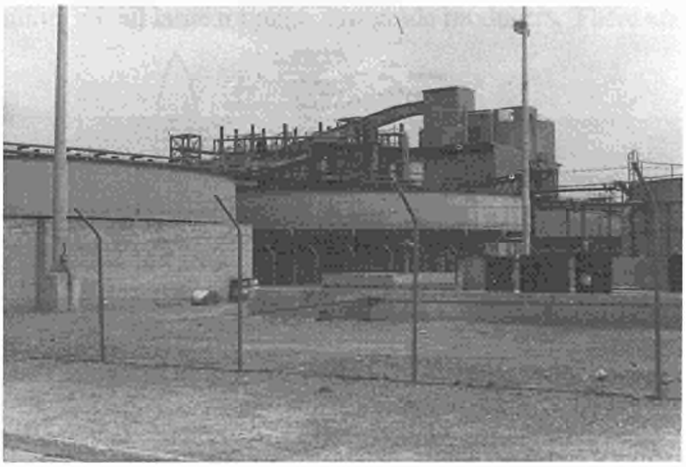
Fig. 2 — Uranium deposits and occurrences in Australia

This mine will also be a major producer of copper and gold. The location of these and other Australian uranium deposits is shown in Figure 2.

Australia has by far the world's largest resources of 'low-cost' uranium with over 730 000 tonnes recoverable at costs of less than USD 80/KgU. However, even this number may be viewed as a rather conservative estimate which is likely to increase significantly in the near future as a result of ongoing studies in the areas around the Ranger and Olympic Dam deposits and at locations such as Kintyre, Manyingee and Mulga Rock in Western Australia. At Olympic Dam alone, the companies undertaking the project (Western Mining Corporation and BP Australia) have estimated a total resource for the deposit of 1.2 million tU.



The Whelan shaft at the Olympic Dam copper-gold-uranium mine in South Australia.



Mixer-settlers at the Ranger uranium mill, Northern Territory, Australia.

Given the enormous resources in Australia, it would be technically feasible to achieve and maintain an annual production of uranium in excess of 20 000 tonnes. However, the present Government is operating what has become known as a 'three mine policy' under which only the three existing mines are allowed to produce uranium. If the planned expansions of Ranger (to 6 000 tU/a) and Olympic Dam (to 3 400 tU/a) take place then production capacity could be around 10 000 tU/a in the early to mid-1990s.

The Ranger uranium ore body exposed in the open pit mine, Northern Territory, Australia.

European companies have a significant interest in uranium deposits in Australia. The BP Group hold 49% of the Olympic Dam project. Rheinbraun Australia (a daughter of RWE), UG Australia Developments (a daughter of Urangesellschaft), Interuranium Australia (a daughter of Saarberg Interplan) and Cogema together own 14% of ERA, the company operating the Ranger deposit. The Ben Lomond and Manyingee deposits are owned by Total and RTZ has a 49% share in CRA, the company responsible for the discovery of the new Kintyre deposit.

Namibia

In 1987 Namibia produced 3 500 tU. This uranium came from the Rossing mine, the only uranium producer in Namibia. The full capacity of the mine is 4 250 tU/a. Because the average grade of the ore is low (around 0.06%), the plant at Rossing needs to process large quantities of ore and is, in fact, the largest uranium processing plant in the world handling some 40 000 tonnes of ore each day.

The uranium resources recoverable at costs of less than USD 80/KgU total around 130 000 tU. About 90 000 tonnes of these occur in the Rossing deposit or, to a lesser extent, in similar deposits. The level of exploration in Namibia appears to be quite low and there are no known plans to open any new uranium mines.

The European mining companies hold a major share of the operating company Rossing Uranium Limited. The British interest is through two daughters of RTZ (Rio Tinto South Africa Ltd and Rio Algom [Canada] Ltd). Total and Urangesellschaft are also shareholders.

Gabon

Uranium production in Gabon in 1987 totalled 800 tU. This came from two deposits — Oklo and Boyindzi. The total production capacity is around 1 500 tU/a. All the ore is processed at the Mounana plant of the Compagnie des mines d'uranium de Franceville (Comuf). Published uranium resources recoverable at less than USD 80/Kg are around 15 000 tU. These occur mainly in the Oklo and Okelobondo deposits.

The Oklo deposit became famous a few years ago when it was discovered that it was a 'fossil' nuclear reactor. Because of the natural conditions that existed back in geologic time, a nuclear chain reaction occurred and was sustained over a long period. The deposit has since been studied extensively, in particular to examine the migration in the geosphere of the radioactive isotopes that result from fission reactions. This information has been useful input into research on how best to deal with the used nuclear fuel from more modern day reactors.

There is a strong French interest in Comuf. The Compagnie française de Mokta (a 100% subsidiary of Cogema) owns 39%. Cogema itself has a 18.8% share and Uranium Péchiney owns a further 10.6%. Comuf is continuing its uranium exploration in the Francevillian Basin in Gabon together with Urangesellshaft (FRG).

China

China has only recently started to export uranium. Details on the country's uranium resources and production are not published officially. However, in recent years a growing number of uranium experts have been allowed to visit China and some of the production facilities. From these visits a clearer picture of the likely role of China as a long-term supplier of uranium is slowly developing.

Statements by Chinese officials indicate that deposits have been discovered that would supply the fuel for 15 000 MWe installed nuclear capacity for some 30 years, in addition to military needs. This would suggest around 100 000 tU though some western experts believe this to be an underestimate of the resources. An OECD(NEA)/IAEA study estimated that very large quantities of uranium — well over one million tonnes — remain to be discovered in China.

It is thought that there are at least 10 operating uranium mills in China, the largest with annual capacities exceeding 1 000 tU. The ore fed into these mills is often brought long distances from a number of small mines. The total production capacity is believed to be within the range 4 000-6 000 tU/a. Given the amount of discovered resources and the very large potential for additional discoveries, there appears to be little doubt that this production could be maintained well into the next century. As China's uranium requirements are likely to remain quite modest over the next decade or so — no more than 6 000 tU to the year 2000 — a substantial part of the production could be available for export.

United States of America

Since reaching a peak production of 16 800 tonnes of uranium in 1980, there has been a spectacular decline to below 5 000 tU in 1987. Meanwhile, the US continues to be the largest single consumer of uranium with annual requirements for its nuclear power programme exceeding 13 000 tU. It has therefore changed from being a major exporter to a major importer of uranium.

Discovered resources recoverable at costs of less than USD 80/KgU fall between 120 000 and 150 000 tU. Production comes from 16 different centres. Only five of these centres can be classed as 'conventional' mines and mills (where uranium is the main product recovered from mined ore) while six are '*in situ* leach' facilities (by pumping a solution into the deposit which leaches the uranium out of the ground without digging out the ore) and five are 'by-product' operations (usually where uranium is recovered as a by-product of the production of phosphate or copper).

Based on existing and committed facilities, the quantities of uranium which could be produced at costs of below USD 30/lb U_3O_8 could decline even further over the next few years. It is only by mining some of the large quantities of higher cost uranium (over 300 000 tonnes of which are known to exist) or by realizing some of the sizeable potential for additional lower cost uranium that the production in the US could increase. It has been estimated that the US could produce near to 12 000 tU/a by 1995 at costs of USD 50/lb U_3O_8, but the prices required to cover such costs must be considered unlikely. An annual production in the range 4 000-6 000 tU/a would appear reasonable over the next decade — unless there is a ban on importing uranium into the country.

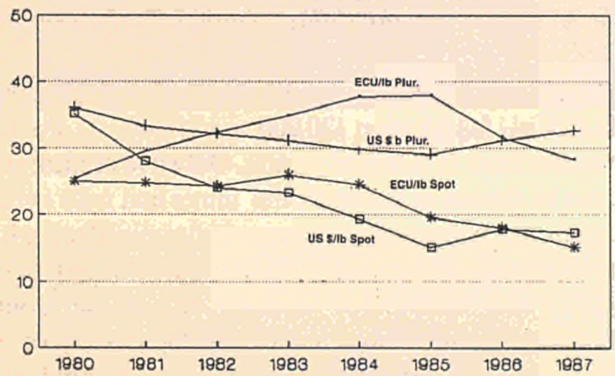
British, French and German companies have interests in some of the US production.

The price of uranium

When discussing the price of uranium it is necessary to distinguish between the price paid under 'pluriannual' contracts (contracts providing for deliveries extending over more than 12 months) and 'spot' contracts (contracts providing for either one delivery or deliveries extending over a period of a maximum of 12 months). Traditionally, the price of uranium is given in USD/lb U_3O_8. A price of USD 30/lb U_3O_8 is equivalent to a price of USD 80/kgU.

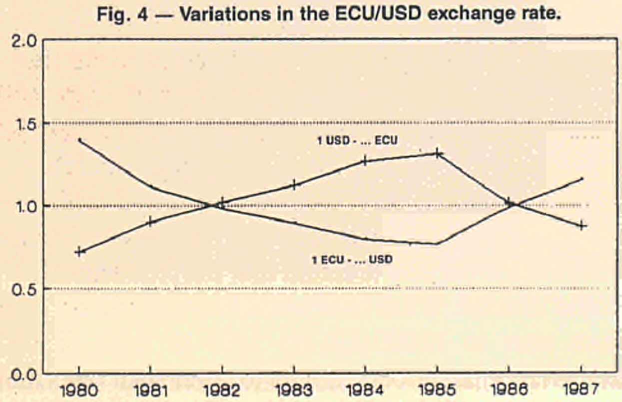
In 1987, according to data published by the Euratom Supply Agency, the Community paid, on average, USD 32.5/lb U_3O_8 or ECU 28.25/lb U_3O_8 for deliveries under pluriannual contracts and USD 17.25/lb U_3O_8 or ECU 15/lb U_3O_8 under 'spot' contracts. Deliveries under 'spot' contacts represented about 17% of the total in 1987. The evolution of the uranium price in recent years is illustrated in

Fig. 3 — Uranium prices for spot and long-term contracts in ECU and USD



Source: Euratom Supply Agency.

Fig. 4 — Variations in the ECU/USD exchange rate.



Source: Euratom Supply Agency.

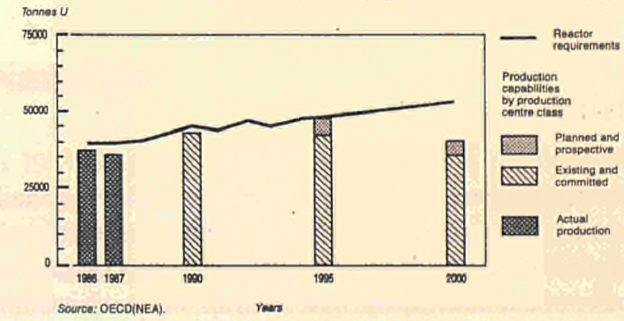
Figure 3. Variations in the ECU/USD exchange rates account for the differences between the trends when plotted in ECU and those in USD (see Figure 4).

A few thoughts on the longer term supply

Current western world production (less than 36 700 tU in 1987) is less than annual requirements (37 700 tU in 1987). The difference between the two is made up mainly by drawing down of 'excess' stocks and imports from China. This situation could continue for a few years.

A plot of reactor uranium requirements against uranium production capabilities for the period to 2000, as prepared by the OECD (NEA) is given in Figure 5. This would appear to indicate that production and requirements would not be very different until around 1995 but that before the end of the century a production shortfall could occur. However, this forecast gives a rather pessimistic picture of the likely situation. There is a possibility that the actual uranium requirements could be lower than forecast — partly as a result of slippages in installing some planned new capacity but also because of additional uranium savings through greater use of uranium and plutonium recycle. At the same time the production projection does not include potential production from some low cost uranium resources — in particular those in Australia which have not received the Australian Government's approval for their development.

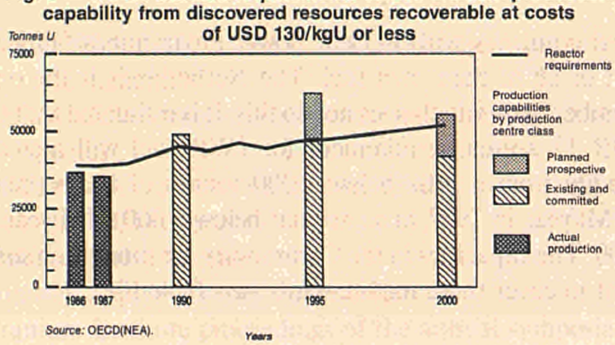
Fig. 5 — WOCA Uranium requirements versus production capability from discovered resources recoverable at costs of USD 80/kgU or less



Source: OECD(NEA).

Figure 6 shows a similar comparison between uranium requirements and 'higher cost' (USD 130/kgU or USD 50/lb U_3O_8) production. This shows that all requirements could be met as long as the price rose to cover the higher costs of production. However, in view of the large quantities of lower cost uranium that have already been discovered, it is thought likely that there will be little need for

Fig. 6 — WOCA uranium requirements versus uranium production capability from discovered resources recoverable at costs of USD 130/kgU or less



Source: OECD(NEA).

this higher cost before the end of the century unless governments impose restraints on the production of uranium or on its availability to consumers.

In the longer term, the supply/demand situation will be influenced by many factors the behaviour of which are not possible to predict with any degree of confidence. On the demand side the major influence will be the rate of growth of future nuclear power programmes and the types of reactors constructed. For example, the large-scale introduction of the fast breeder reactor (FBR) would mean that around 50 times more energy can be obtained from each kilogramme of uranium than is presently achieved by light water reactors (LWRs). On the supply side production will depend on discovering and bringing into production new uranium deposits to replace those which become depleted. There is little doubt that very large quantities of uranium remain to be discovered. However enough of this potential will only be realized with a renewed interest in exploration activity. This may not come about until the producers have a greater financial incentive than today's uranium price.

The alkaline pressure leaching plant at Lodève.

Preliminary studies, mainly computer simulations of the future of the uranium supply industry, indicate that uranium production could be expected to cover likely demand growth through the first quarter of the next century, depending, of course, on sufficient encouragement and funds for exploration and no political restraints on the production and availability of the uranium discovered. Mainly because they base their predictions on extrapolations of already discovered resources and existing geological knowledge, the computer simulations suggest that the countries which presently have the large, high grade (and, therefore, relatively low cost) uranium deposits — such as Canada and, in particular, Australia — could increasingly dominate the supply side of the uranium market. Supply diversification may become a significant issue before supply shortage!

Other steps in the production of nuclear fuel

Most nuclear reactors now use 'enriched' uranium — i.e. uranium enriched in the isotope U^{235} (relative to the main isotope U^{238}). Before the uranium coming from the mine and mill — usually referred to as 'yellowcake' — is enriched it must be converted from U_3O_8 (uranium oxide) to UF_6 (uranium hexafluoride). After enrichment it is made into the fuel elements ready for insertion into the reactor. This final step is known as fuel 'fabrication'.

The Lodève open pit mine.

Conversion

The Community has the capacity to convert all the natural uranium it uses. In practice, however, a significant amount of uranium destined to be used in our reactors is converted in the USA and Canada while the Community industry converts uranium for some non-Member States. The capacities and requirements until the year 2000 are summarized in the following tables.

Table 6: Conversion capacities (tU/yr, U_3O_8 to UF_6)

	1987	1990	1995	2000
France	12 000	12 000	12 000	12 000
UK	9 000	9 000	14 000	14 000
Total EUR 12	21 000	21 000	26 000	26 000

Table 7: Annual conversion requirements (tU/yr)

	1987	1990	1995	2000
Belgium	960	960	1 140	1 140
France	6 200	6 800	6 950.	7 100
FRG	3 500	3 400	3 400	3 400
Italy	300	300	400	400
Netherlands	91	90	90	90
Spain	1 210	1 300	1 300	1 450
UK	1 505	1 976	1 770	1 600
Total EUR 12	13 766	14 826	15 050	15 180

Enrichment

The situation is rather similar for enrichment though here the two external suppliers are the US Department of Energy and Techsnabexport (USSR). Because of some overcapacity and major new technology developments in this field, the enrichment market is a very competitive one. The capacity/requirements situation in the Community is summarized in the following tables.

Table 8: Enrichment capacities (Tonnes SWU/year)

	1987	1990	1995	2000
France	10 800	10 800	10 800	10 800
FRG / The Netherlands / UK	2 150	2 500	4 000	5 500
Total EUR 12	12 950	13 300	14 800	16 300

Table 9: Annual enrichment requirements (Tonnes SWU)

	1987	1990	1995	2000
Belgium	700	700	830	830
France	4 700	5 200	5 600	6 000
FRG	2 600	2 100	2 000	2 000
Italy	264	264	328	328
The Netherlands	55	53	53	50
Spain	750	880	880	1 000
UK	480	865	770	880
Total EUR 12	9 549	10 062	10 461	11 088

Fuel fabrication

Most countries with nuclear power programmes fabricate part or all of their own fuel. The Netherlands is the only Member State which does not do this. It is estimated that the EUR 12 annual requirement for LWR fuel will increase steadily from a little below 2 000 tonnes of heavy metal (tHM)/year in 1987 to somewhat below 3 000 tHM/year in 2000. The capacities in the Community are more than sufficient to cover these requirements (see Table 10).

Table 10: Fuel fabrication capacities (tHM/year)

	1987	1990	1995	2000
Belgium	400	400	400	400
France	1 100	1 100	1 100	1 100
FRG	1 350	1 350	1 350	1 350
Italy	100	100	100	100
Spain	200	200	200	400
UK	200	200	200	200
Total EUR 12	3 350	3 350	3 350	3 550

Conclusions

The European Community is a major consumer of uranium. Because it produces less than 30% of its own requirements it is a major importer of uranium. This dependence on outside suppliers will continue and could well increase as nuclear power programmes grow and unless more fuel efficient reactors are employed.

The western world natural uranium supply/demand situation is such that sufficient quantities of uranium can be purchased to cover the difference between the Community's production and its requirements. It does not appear likely that any significant 'tightening' of the market will occur during the next decade.

Over the same period, the Community has — or can have — all the capacities required to further process the natural uranium to the form ready for loading into its reactors and, in fact, could well increase the amount of these services offered to other countries.

In the longer term, beyond 2000, the Community would be expected to remain self-sufficient in terms of conversion/enrichment/fabrication services. It will also remain dependent on external suppliers for a major part of its natural uranium. The availability of the necessary uranium will depend on a continuing or, more likely, expanding exploration effort — in which companies from our Member States already play the major role — and political goodwill between suppliers and consumers.

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Energy grants and loans from the Community in 1987

In 1987 the Community awarded the energy sector grants and loans totalling ECU 4.0 billion, of which ECU 880.9 million took the form of grants and ECU 3 145.8 million took the form of (EIB, ECSC, NCI, and Euratom) loans.

Grants from the general budget and the ECSC budget

Community grants to the energy sector in 1987 (see Table 1) fell back in 1987 to their 1985 level, mainly because of the considerable reduction in Regional Fund support for energy infrastructure projects to ECU 150.9 million, i.e. about one-third of the 1986 level.

Table 1
Community energy grants in 1986 and 1987 — by budget heading

	1986		1987	
	MECU	%	MECU	%
Energy (Chapter 70)	158.6	14.5	148.2	16.8
Energy R&D (Chapter 73)	364.5	33.37	404.4	45.9
ERDF	422.3	38.6	220.5	25.0
● Projects	418.6	38.3	150.9	17.1
● VALOREN programme	—	—	43.2	4.9
● IMP contributions	2.0	0.2	12.0	1.4
● Specific measures	1.7	0.2	14.4	1.6
● Integrated Mediterranean programmes	1.4	0.1	11.0	1.2
● Additional contribution EAGGF contribution to IMPs	0.3	—	3.0	0.3
ECSC budget	146.3	13.4	95.5	10.7
Total	1 093.4	100.0	880.9	100.0

In addition, 1987 saw the first Regional Fund commitments for the Valoren programme (see *Energy in Europe* Nos 4 and 6) and, after Crete in 1986, for the five other regions of Greece concerned by the integrated Mediterranean programmes. In the case of Valoren the aid amounts to ECU 43.2 million out of an overall budget of ECU 382.8 million for the period 1987-91 and in the case of the IMPs it is estimated at around ECU 12 million for the six Greek regions as a whole. Adding the aid granted as part of the Valoren programme and the IMPs in Greece to the support for projects, the total ERDF contribution amounts to ECU 206.1 million, i.e. 5.8% of the total assistance from the Fund (excluding the specific measures).

This is the smallest share that the energy sector has received since 1979.

As part of the specific measure to improve the security of energy supply in the Mezzogiorno (Italy), the ERDF also granted a ECU 14.4 million subsidy for projects to use renewable energy sources there.

In 1987 energy R&D appropriations were by far the biggest single item in the Community's energy grants budget: ECU 404.4 million or 46% also of the total. This is the result of an increase in the appropriations for the thermonuclear fusion programme and the fact that the third shared-cost non-nuclear energy programme has now taken off.

The support granted in 1987 — the second year of the programmes in question — to projects using new energy technologies totalled ECU 36.5 million in the oil and gas sector and ECU 103.8 million for demonstration projects, giving a total of ECU 140.3 million.

ECSC R&D appropriations (ECU 25.1 million) were up on 1986. However, there was a definite reduction in interest subsidies to facilitate the marketing of Community coal. The decrease in loans for the retraining of workers reflects the partial payment of aids agreed in 1987, the balance being paid in 1988. At the end of 1986 the arrangements for subsidizing coal for the steel industry (Article 95 of the ECSC Treaty) expired.

The breakdown of the energy grants paid out in 1986 and 1987 by recipient sector is set out in Table 2.

Table 2
Community energy grants in 1986 and 1987 — by sector

	1986		1987	
	MECU	%	MECU	%
Solid fuels	164.9	15.1	111.0	12.7
Oil and gas	214.8	19.6	61.7	7.0
Nuclear energy	338.0	30.9	341.4	38.7
● fission	150.7	13.8	117.4	13.3
● fusion	187.3	17.1	224.0	25.4
Electricity	239.0	21.9	128.0	14.5
New and renewable energy sources	55.4	5.1	84.1	9.5
Rational use of energy	74.2	6.8	81.0	9.2
Others (Valoren, IMPs, ERDF/IMPs)	—	—	66.2	7.7
Energy planning and studies	7.1	0.6	7.5	0.9
Total	1 093.4	100.0	880.9	100.0

With ECU 224 million, the fusion programme (direct action and shared-cost action) was in 1987 by far the biggest beneficiary of Community assistance in the energy sector, accounting for over one quarter of the total appropriations.

Adding the aid granted for fission, mainly research carried out at the JRC, nuclear energy accounted for nearly 40% of the total Community subsidies of the energy sector.

The implemention of the Valoren programme in 1987 in particular resulted in financial support being given to projects concerning new and renewable energy sources and the rational use of energy. While it is difficult to give a breakdown sector by sector, on an annual basis, of the budgetary commitments in question, it can be estimated that well over half of the appropriations earmarked in 1987 for energy in these programmes was for alternative sources and energy savings.

Thus, what with the support for demonstration projects and the shared-cost R&D, between 20 and 25% of the total aid granted in 1987 by the Community to the energy sector was for new energy sources and the rational use of energy.

As the appropriations for R&D and new energy technologies in the sector were maintained, it was possible to limit to some extent the reduction in the share of subsidies for solid fuels. Aid for the redeployment of miners (Article 56(2)(b) of the ECSC Treaty) fell more or less to the 1985 level after the exceptionally high level of 1986.

The major reduction in ERDF support for energy infrastructure projects particularly affected the respective shares of oil and gas (natural gas transmission) and electricity (power stations and distribution networks) which were much lower than in previous years.

Table 3
Community grants for energy projects in 1987 by recipient sector and source of funding
(General Budget and ECSC Budget)

	MECU	%
1. Solid fuels	111.0	12.7
General Budget	17.2	1.9
Demonstration projects	16.9	1.9
Liquefaction and gasification		
ERDF	0.3	—
ECSC Budget	93.8	10.7
Interest subsidies	2.3	0.3
Coking coal	—	—
Research and development	25.1	2.9
Redeployment of workers	66.4	7.5
2. Oil and gas	61.7	7.0
Community technological development projects	36.5	4.1
ERDF	25.2	2.9
3. Nuclear fission	117.4	13.3
Transport of radioactive materials	0.4	—
Research and development	116.7	13.2
Direct action — JRC	94.2	10.7
Cost-sharing	22.5	2.5
ERDF	0.3	—
4. Nuclear fusion		
Research and development	224.0	25.4
Direct action — JRC	15.1	1.7
Cost-sharing	208.9	23.7
5. Electricity	128.0	14.5
ERDF	125.0	14.2
EAGGF/IMPs	3.0	0.3
6. New and renewable energy sources	84.1	9.5
Demonstration projects	33.1	3.8
ERDF (specific measures)	14.4	1.6
Research and development	36.6	4.2
Direct action — JRC	8.7	1.0
Cost-sharing	27.9	3.2
7. Rational use of energy	81.0	9.2
Demonstration projects	53.9	6.1
Energy saving	34.3	3.9
Substitution of oil and gas	19.6	2.2
Research and development	27.1	3.1
Direct action — JRC	—	—
Cost-sharing	27.1	3.1
8. Others (Valoren, IMPs, ERDF/IMPs)	66.2	7.5
9. Energy planning	6.6	0.7
10. Energy studies	0.9	0.1
Grand total	880.9	100.0

Energy loans from Community financial instruments

The significant slowing down in 1987 compared with recent years in the Community's general lending activity was felt particularly acutely in the energy sector. After the record level reached in 1986, when they amounted to ECU 3 230.4 million, loans from the Community institutions in 1987 totalled ECU 3 141.8 million, a reduction of nearly 3%. Nevertheless, with 36%, energy's relative share was still the biggest in 1987 of all the sectors of the economy which apply to the Community's financial institutions for loans.

The breakdown of this total volume of over ECU 3.1 billion is examined below by source of funding, by recipient sector and by Member State.

By source of funding

The EIB remains the main source of Community loans for European companies investing in energy production, consumption and transmission projects, with a share of three quarters of the total loans, despite falling in absolute terms from ECU 2.6 million in 1986 to ECU 2.4 million in 1987.

In 1987 the ECSC was back in its 1984 position. Following the major upturn in activities in 1986 with a loan of ECU 103.6 million for Ruhrkohle, two loans totalling ECU 283.2 million were paid out to British Coal in 1987.

ECSC loans for the financing of thermal power stations also rose considerably in 1987 to ECU 123.3 million compared with ECU 8.7 million in 1986. As in the previous year projects in the Federal Republic of Germany were the recipients.

Eleven loans at reduced rates of interest totalling ECU 42.6 million were granted for investment designed to promote the use of Community coal in industry in Germany, France and the United Kingdom and for district heating in France.

Euratom's lending activities continued in 1987 for the financing of investments in industrial activities in the nuclear energy sector and industrial fuel-cycle installations. In 1987 five loans totalling ECU 313.7 million were granted for investment projects by four companies in the United Kingdom (fuel cycle), France (fast-neutron reactor), Italy and Germany (nuclear power stations).

NCI IV, which the Council approved on 9 March 1987, is intended solely for small and medium-sized enterprises. Where energy is concerned, it is confined to the financing of investment in rational use. Only one global loan was granted for this purpose in 1987 (in Spain).

By recipient sector

The main feature in 1987 was the considerable reduction in the nuclear energy investment's share of the total volume of loans granted by the Community. At 17%, the proportion is less than half the average since 1979. EIB loans totalling ECU 214.4 million (compared with ECU 313.7 million in Euratom loans) were granted to a power station in France (ECU 35.5 million) and to a power station (ECU 26.5 million), a waste-storage facility (ECU 65.9 million) and a reprocessing plant (ECU 88.5 million) in the United Kingdom.

The Italian Government has decided to convert the Montalto di Castro nuclear power station into a multi-fuel installation. This station was granted several Euratom and EIB loans between 1983 and 1987.

In 1987 the electricity sector was the biggest energy-sector borrower of Community funds, with a total of around ECU 950 million, as a result of the favourable trend in ECSC funding for coal-fired power stations and the marked increase in EIB loans.

As in 1986, ENEL (Italy) borrowed nearly half the Community funds for investment in coal-fired, hydroelectric and geothermal power stations and for the funding of the transmission and distribution network in several regions of southern Italy. Electricity companies in the Federal Republic of Germany invested some ECU 270 million (EIB and ECSC loans) in the construction, extension and modernization of coal-fired power stations and related desulphurization facilities.

The oil and gas sector fell to its lowest level in relative terms since 1981. The only loans granted were from the EIB's own resources, to finance the exploitation of oil and gas resources in Italy and the British sector of the North Sea, natural gas storage, transmission and distribution facilities in Denmark and Italy and the modernization of an oil refinery in Greece.

Although in percentage terms loans to the solid fuel sector tripled between 1986 and 1987 (9.6% of the total compared with 3.2%), the activity in question was confined to the two ECSC loans already mentioned to British Coal and an EIB loan of ECU 17.9 million for a lignite mine to fuel a power station in Greece.

There was considerable activity in 1987 as regards the funding of projects to develop alternative energy sources and promote the rational use of energy. Virtually all the countries which generally borrow from the Community's specialized institutions were involved. A considerable proportion of these operations, which totalled ECU 730 million (23.2% of the total) was in the form of global loans from the EIB (own resources and NCI resources) and from the ECSC.

By recipient Member State

In 1987 Italy, with a share of nearly 35%, was again by far the biggest borrower of funds from the Community lending institutions. The total of ECU 1.1 billion is the biggest ever and is 4% up on 1986.

The United Kingdom borrowed much less than in 1986 because it made much less use of the EIB to finance its nuclear investments. Its relative share (23.7%) has fallen to the 1984 level, but the United Kingdom is still in second place.

In 1987 the Federal Republic of Germany kept the third place it occupied in 1986 (13.2% of the total). It should be emphasized that two-thirds of its total loans (EIB, ECSC and Euratom) were for the financing of energy projects. This places Germany after Denmark which usually has the highest proportion of all the Member States (87.5% in 1987).

In 1987 Denmark was in joint fourth position with France with a share of 8.9% of total Community loans for energy production, transmission and utilization projects. Denmark, which in 1987 only applied to the EIB for loans, devoted 82.6% of its total loans to finance its strenuous efforts to set up and extend the district heating network throughout Denmark.

France's share was bigger than in 1986, but this is attributable to non-nuclear sectors. With a total of ECU 111.3 million (EIB and ECSC), France's Community loans to finance rational use of energy projects are the biggest after Denmark and Italy. To a large extent these projects are carried out by local authorities or public establishments.

In addition to the two loans already mentioned, Greece borrowed, again from the EIB, ECU 26.0 million to establish a high-voltage power line in the Athens region and to build small and medium scale hydroelectric power stations on the river Achelous. At ECU 90.5 million (2.9% of the total) the total for the five loans is less than the average since 1983.

The loans applied for by Spain and Portugal from the Community institutions to finance energy projects continued to be on the low side in 1987 compared with loans for investment in other branches of the economy. Four loans from EIB and NCI resources were granted in the two new Member States, for a hydroelectric power station project in Spain (ECU 50.8 million) improving two electricity grids in Portugal (ECU 6.3 million) and energy-saving projects (a global loan in each of the two countries).

In 1987, as in 1984 and 1985, Ireland joined the ranks of the Benelux countries which traditionally make very little or no use of the Community's specialized institutions to finance their energy investments.

As in 1973 and 1977, in 1987 the EIB granted a loan (ECU 108.7 million) for the gas pipeline which takes natural gas from the Soviet Union to the Community via Austria.

Table 4
Loans granted in 1987 (MECU)

	Solid fuels	Oil & gas	Nuclear energy	Electricity	RUE & NRES	Total	%
EIB	17.9	633.8	214.4	825.6	665.6	2 357.2	75
NCI	—	—	—	—	21.8	21.8	0
ECSC	283.2	—	—	123.3	42.6	449.1	14
Euratom	—	—	313.7	—	—	313.7	10
Total	301.1	633.8	528.1	948.9	729.9	3 141.8	
%	9.6	20.2	16.8	30.2	23.2		100.0

Table 5
Loans granted in 1987 (MECU)

	D	DK	E	F	GR	I	P	UK	Others	EC	%
EIB	244.8	279.1	50.8	199.9	90.5	979.3	56.4	347.7	108.7	2 357.2	75.0
NCI	—	—	21.8	—	—	—	—	—	—	21.8	0.7
ECSC	151.0	—	—	8.7	—	—	—	289.6	—	449.1	14.3
Euratom	24.3	—	—	74.6	—	108.9	—	108.9	—	313.7	10.0
Total	420.1	279.1	72.6	280.2	90.5	1 088.2	56.4	746.2	108.7	3 141.8	
%	13.4	8.1	2.3	8.9	2.9	34.6	1.8	23.7	3.5		100.0

Table 6
Energy loans from Community financial instruments (MECU)

	1982	1983	1984	1985	1986	1987
EIB	1 228.5	1 643.3	1 894.7	2 231.3	2 574.2	2 357.2
NCI	131.4	315.4	250.0	9.4	91.1	21.8
ECSC	302.9	396.2	124.4	90.8	121.9	449.1
Euratom	361.8	366.4	186.0	211.0	433.2	313.7
Total	2 024.6	2 721.3	2 455.1	2 542.5	3 230.4	3 141.8

Support programme for technological development in the oil and gas sector

In July the Commission approved a report to the European Parliament and the Council on the application of Council Regulation (EEC) No 3639/85 of 20 December 1985,[1] which outlines the measures taken to apply the Regulation and the main results obtained by 31 December 1987.

The Regulation itself, simply an extension of Regulation (EEC) No 3056/73, provides for financial support to be granted to Community technological development projects relating to exploration, production, storage or transportation activities in the oil and gas sector which are of crucial importance for the security of the Community's supplies. The amount granted may not exceed 40% of the cost of the project and must be repaid if the project proves a commercial success.

Implementation of the programme

Over the period covered by the report — the first two years of application of the Regulation — two invitations to submit proposals were published in the Official Journal: the first, for 1986, attracted 122 proposals for a total investment of ECU 247 million; the second, for 1987, produced 143 proposals for a total capital outlay of ECU 333 million.

After consulting the Advisory Committee on oil and gas projects, the Commission granted 76 projects financial support totalling ECU 37.9 million in 1986, followed by ECU 36.6 million for 76 other projects in 1987. Production activities took most (59% of the support granted in 1986 and 1987, followed by geophysical prospecting (18%) and transportation (13%)

Over the first two years of the programme a large proportion of the projects were submitted by smaller firms (40%) or by partnerships between businesses in different Member States (17%). These are the two special priorities added by Regulation 3639/85 to the criteria set out in the original Regulation.

Results

Technological development projects normally take three to five years to complete plus, on average, two more years to market the new technique. For this reason, only incomplete results can be given covering mainly the technical and financial performance and dissemination of the know-how.

Technical results

Without going into too much detail, the technical results illustrate the scale and quality of the work done. From geophysics (better recording of seismic data in order to learn more about the fields), to drilling (optimum automation and improved data acquisition systems), production (development of an underwater production station and trials on tension leg platforms) or transport (improved systems for repairing subsea pipelines and more effective pipeline corrosion tests), all the projects completed so far have made a significant contribution to Europe's security of supply and to cutting costs in the oil industry.

Out of the 245 projects completed since Regulation 3056/73 entered into force, 32% have been complete technical successes and 55% partial technical successes. Only 13% were failures.

Financial results

Constant improvements in contract administration combined with a rigorous budgetary policy has enabled the Directorate-General for Energy to make maximum use of all the commitment and payment appropriations allocated to it for 1986 and 1987.

Already contractors who have advanced to the commercial exploitation stage have repaid ECU 52 million or 25% of the support paid. One reason for the discrepancy between this figure and the technical success rate lies in the problems caused for the oil and allied industries by the fall in oil prices since 1986.

Dissemination of know-how

To back up the steps taken by the contractors themselves to disseminate their know-how, the Directorate-General for Energy has organized symposia, seminars and technical conferences. It has also published regular status reports on

[1] COM(88) 380 final.

the projects[2] and set up the Sesame database containing details of the projects.

Overall assessment of the programme

The current programme under Regulation 3639/85 will end on 31 December 1989. However, when the programme was adopted in December 1985 the Commission undertook to report to the Council, by the end of 1988, on whether, and if so how, the programme should be continued or other measures taken. The report is currently being drafted. The assessment is divided into four stages:

The first stage is an in-depth analysis of the oil-related industries in the Community. It clearly demonstrates that this sector is very important (with a world market share of 20%) but as a one-product industry with a single objective (to prospect for and produce oil) is highly sensitive to fluctuations in oil prices. Nevertheless it is essential for the Community's security of supply to maintain its technological capabilities and its highly skilled workforce.

The second stage was the symposium organized by DG XVII in Luxembourg on 22-24 March 1988, as reported in *Energy in Europe* No 11.

Recently the Commission embarked on the third stage by ordering a technical and economic analysis of the programme's results from an independent consultant assisted by experts from the industry in different Member States to place the results in a Community context. Their final report was submitted to the Commission at the end of August.

All the data, information, conclusions and suggestions received by the Commission during this preparatory work will be brought together in the final report submitted to the Council in response to the commitment given at the end of 1985. In the light of this report, the Commission will decide on any further action on oil and gas technology to propose to the Council. It will submit this report by the end of 1988.

Conclusions

Despite the limited funds available, the keen response from the industry points to the conclusion that the results of the new support programme which began on 1 January 1986 show that it is up-to-date, dynamic and of growing interest to the Community's oil and allied industries.

Commercial exploitation of the results has continued to increase, though not as fast as in the past, because of the deteriorating operating conditions in the oil and allied industries following the fall in oil prices starting in 1986.

In short, the results of the first two years of the new Regulation were generally encouraging, considering the economic situation, and bear out the decision taken by the Council at the end of 1985 to launch a new four-year programme.

2 Proceedings of the Second symposium /1985); Third status report (1987).

Piling

There is nothing new under the sun.

When the Royal Palace in Amsterdam was built in 1650, 13 659 wooden piles were driven into the soil to support the weight of the building. Soil conditions were such that without piles the building was not stable and certainly would not exist for a long time. Also due to good pile driving more than 300 years later the building is still serving its purpose.

When in 1982 BP Petroleum Development Ltd installed a production platform at Magnus Field in block 211/12 in the North Sea UK sector, 36 piles were driven, serving more or less the same purpose as the 13 659 piles of the Royal Palace.

Pile at test location.

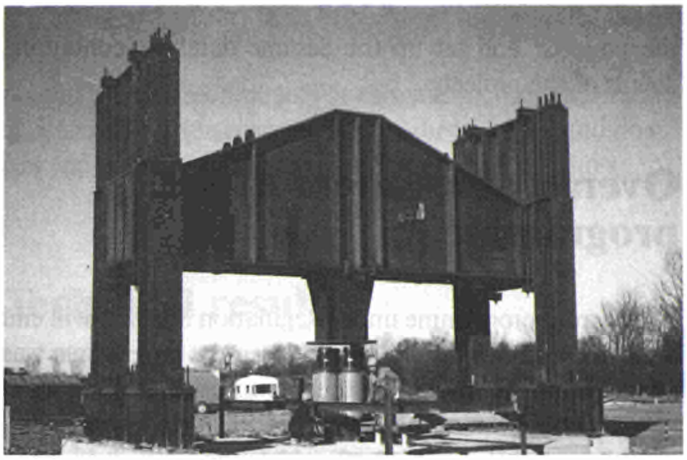
Nevertheless, there are some differences.

Offshore platforms, when standing on the sea bottom, can be roughly divided into two categories: gravity platforms and piled platforms.

Gravity platforms are placed on the sea bottom and remain upright and stable due to their own weight. This can only be done if soil conditions of the sea bottom permit it.

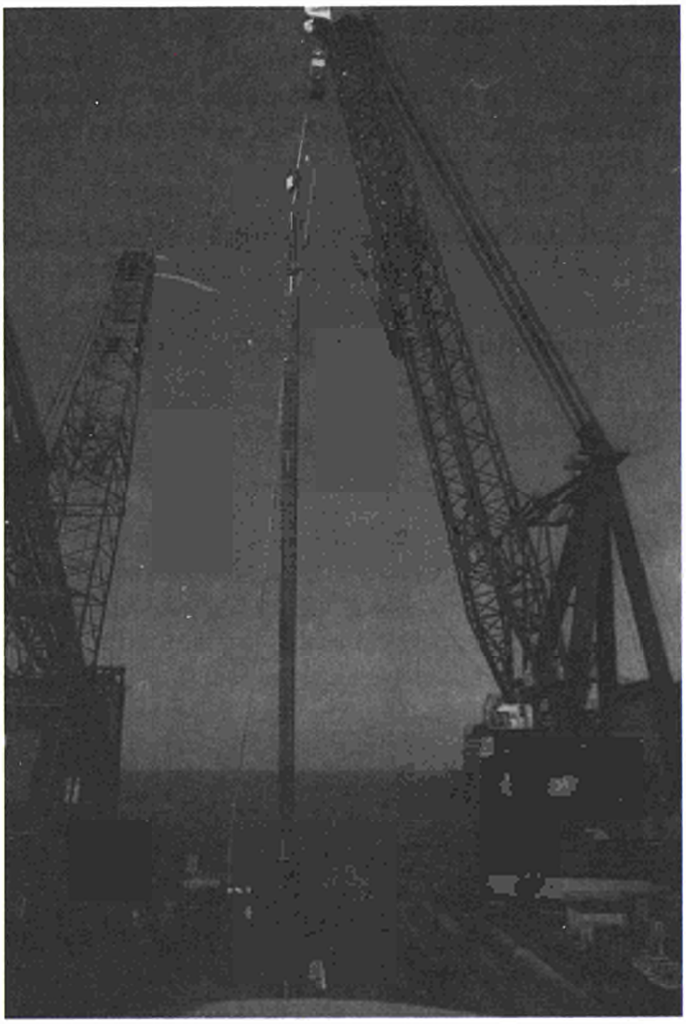
Piled platforms are standing on the sea bottom but their stability is guaranteed by piles. Those piles, hammered down into the sea bottom soil, are fixed to platform legs or base.

The Magnus platform is a 210 m high tower type steel structure with four legs. Total weight is approximately 80 000 tonnes. Legs have a diameter of 10 metres. Each leg is supported by 9 piles. The piles are open-ended steel tubes of 2.13 m diameter and 6.3 cm wall thickness. Length is 105 m. At the bottom of each leg, 9 pile sleeves (19.5 m high) are fixed



Load reaction frame onshore pile testing.

around the leg. When the platform is standing on the sea bottom at a water depth of 186 m, the piles are hammered down through the sleeves and penetrate into the sea bottom soil approximately 85 m. After that the piles are fixed into the sleeves (also at 180 m water depth). This fixes the platform solidly to the sea bottom. The piles were hammered down into the sea bottom, using a. o. Menck's MHU 1700 underwater hammer. The hammer development has been supported by the Communities (project TH. 06. 08/80) under the

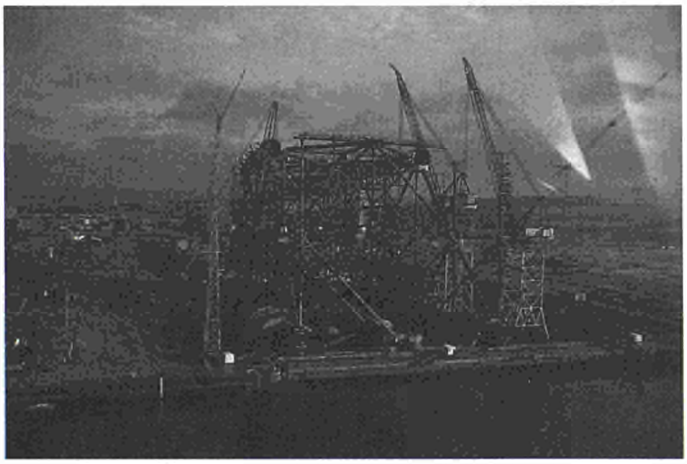


Menck's underwater pile driving hammer.

programme to support Community projects in the oil and gas sector — Regulation 3056/73.

The lower section of one of the four legs and the piles supporting that leg have been instrumented extensively with strain-gauges, accelerometers and mudmat pressure sensors. This was done in the framework of the Foundation Monitoring Project on the Magnus structure to obtain fullscale data on the behaviour of the foundation of an offshore production platform.

The actual loads imposed on the piles and the seabed by the structural and environmental forces (weight, waves, wind and current) are determined and related to those calculated by the conventional methods of analysis utilized at the design stage. The environmental loads, acting on the pile group in real conditions and at full scale up to a maximum wave height of 21 m, have been monitored over a period of more than three years. Also this project has been supported by the Commission in the hydrocarbon scheme (projects TH. 06.014/81 and TH. 15.035/82).



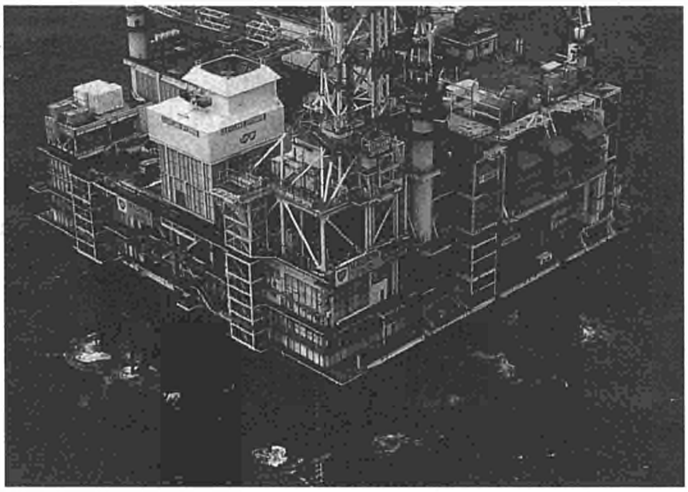
Magnus platform under construction.

To recommend a more fundamental and rigorous approach to the computation of the ultimate axial load capacity of piled foundations, another project has been supported by the Commission (project TH. 15.65/84).

Two large-scale pile load tests have been performed by BP at onshore locations in clays similar to those encountered by oil and gas platforms in the North Sea. Two 762 mm diameter tubular steel piles were driven into two different soils to 30 and 55 m penetration. Each pile was loaded to failure in axial compression via hydraulic jacks reacting against an anchored frame. After that, sustained loading and cyclic load tests were performed. The piles and surrounding soil were instrumented to monitor their response to pile installation and subsequent loading.

Although there is nothing new under the sun, the differences are evident. Who could imagine in 1650 that steel piles of more than 2 m diameter and over 100 m length could be hammered down with a hammer, operating underwater at a depth of 186 m and that a steel tower of over 200 m height and 80 000 tonnes weight could be erected in that water depth? Moreover, that loads acting on piles and soil could be measured and monitored over long periods.

In supporting these projects, the Commission's programme of support for technological development in the hydrocarbons sector has contributed to obtaining a better understanding of piling phenomena and to improve operational capabilities.



Magnus platform.

Energy efficiency; the good and bad news[1]

Improved energy efficiency has been an essential objective in energy strategy for the European Communities since the first oil crisis. In 1986 the Council of Ministers went even further than before in setting the ambitious target of improving, by 1995, energy efficiency in the Community by 20%.

But how should progress along this road be measured? What kind of yardstick could be used to assess the success of programmes for improving energy efficiency? Does a drop in energy demand, or in the amount of energy apparently required to produce one unit of GDP, necessarily mean that energy efficiency is improving?

To help answer these questions the Commission's Directorate-General for Science, Research and Development (DG XII) and the Directorate-General for Energy (DG XVII) commissioned the Fraunhofer-Institute to develop a methodology, which would provide a consistent basis for measuring the energy intensity of the Community as a whole as well as of each individual Member State. The first report covered 10 of the Community Member States for the period 1979-84. It was reviewed in the July 1987 edition of *Energy in Europe* No 7. Recently the Fraunhofer-Institute have updated their analysis to incorporate Spain and Portugal and to extend the analysis to include 1985.

The message

The good news is that improving energy efficiency continues to contribute to reducing energy demand.

The bad news is that the rate of increase in efficiency improvements is already slowing down.

Some commentators are not at all optimistic about the future. There is certainly cause for some concern. While energy efficiency as such will certainly continue to improve, the rate of improvement could remain sluggish. Technology is certainly improving and over the very long term will lead to major changes in how we use energy. But over the next 10 years can we be as optimistic in the present environment? With relatively low energy prices and steady increases in economic welfare, demand for energy may indeed increase faster than current thinking would suggest. The break on energy consumption which was expected to come from increased efficiency is likely to be less powerful than we had hoped a few years ago.

A recently concluded review of Member States' energy policies[2] warned that if no new policy measures are introduced at Community and/or national level it now seems to be clear that the achievement of a minimum 20% energy efficiency improvement by 1995 will not be realized. At a time of low energy prices there are no longer the strong market signals needed to encourage energy efficiency measures and the easily achievable efficiency gains have already been realized. Final demand in all consumption sectors, but specifically in transport, could grow faster than previously anticipated. If present trends continue, final energy consumption in the Community would be approximately 70-110 Mtoe higher in 1995 than that required by the objective. This additional 70-110 Mtoe not only corresponds to approximately ECU 8-13 billion a year at current oil prices, but would be a serious setback making the Community much more vulnerable to supply shortages or price rises or both.

Because of these concerns, concerns reinforced by the latest update of the earlier analysis, a revisit of 'what has been happening to energy efficiency' is timely. Also the recent work now incorporates Spain and Portugal.

The method

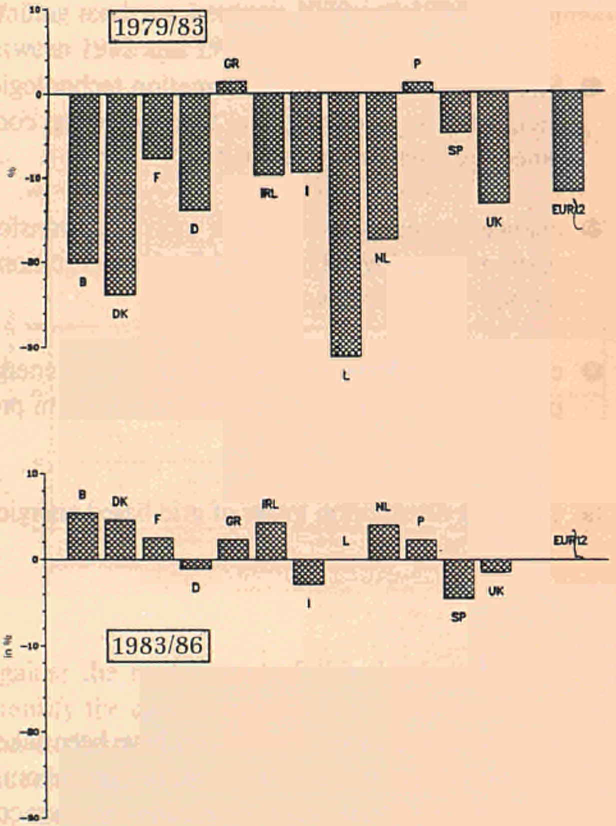
The usual practice of interpreting reduced intensity, defined here as the ratio of the final energy consumption and gross domestic product, as a measure for energy conservation — or even for improved energy efficiency — is questionable. Why? Because the final energy consumption depends on many determining factors such as annual variations in the weather and consumer stocks, changes in production and available income, structural changes due to the business cycle, long-term structural changes in the economy, shifts between energy carriers, and changes in consumer behaviour. Figure 1 shows the changes in energy intensity for the Community for the period 1979 to 1986.

Therefore, the reductions in energy consumption as well as in energy intensity are not always the result of an energy conservation process in a technical sense (energy efficiency). To present more reliable results on the progress in energy efficiency, this analysis explicitly took into consideration the abovementioned factors. These strongly influenced energy consumption either as a short-term variation (weather, consumer stocks, business cycle) or as a long-term trend.

1 This article is based on an update of a report prepared by the Frauenhofer-Institut and published in *Energy conservation indicators* (Springer Verlag ISBN 3-540-18536-4) in 1987. The recent analysis extends the period investigated from 1979 to 1983 to include the results for 1983-85.

2 COM(88) 174.

Fig. 1: Changes in energy intensity, EUR 12 and the member countries, 1979 to 1986.



Sources: OECD/IEA 1988.

This approach presents hopefully more reliable results on rational energy use (energy efficiency) since the indicators used allow for a distinction between long-term and short-term factors influencing energy consumption. In fact, two of the short-term effects, consumer stock variations and the influence of the weather conditions could be determined precisely. The structural effects due to the business cycle, i.e. the effect of the above average growth of energy-intensive industrial sectors in the upswing phase and the below average growth in the downswing phase, had to be estimated by a simple method. These results are less reliable, but accurate enough to determine the effect of intersectoral changes, improvements in energy efficiency, and to some extent the influence of higher levels of comfort, particularly in space heating and private passenger transport.

The analysis underlying the Frauenhofer-Institute's study is complex and time consuming, but necessary if one is to come to an indicator of energy efficiency rather than influences of the above factors which are contained in energy intensity measures.

The methodology and the data analysis used in the study are illustrated diagramatically in Figure 2 and can be summarized briefly as follows:

Final energy consumption data were split into fossil fuels/district heat consumption and electricity consumption or into energy uses. Therefore, energy efficiency indicators distinguish between these two groups of final energy in the industrial and agricultural/commercial/public sectors, or between different energy uses in the residential and transportation sectors.

The analysis distinguishes between six energy consuming sectors:

- five final sectors (industry, primary/tertiary sector, transportation, residential sector, and non-energy use); and
- the transformation sector.

Distribution losses of final energies as well as changes in foreign trade in derived energy products were considered.

In the analysis of the final energy sectors:

(i) The level of activity (production or consumption) was considered by defining a specific final energy consumption on a disaggregated level for each sector. The denominator of specific energy consumption represents economic or physical/technical factors such as value-added, mileage, number of households, living area per household.

(ii) Final energy consumption data in the residential and primary/tertiary sectors were readjusted for climatic influences by using national degree-day data. Consumer stock variations were considered as far as data were available.

(iii) Structural influences were considered by disaggregating four of the final energy sectors (intersectoral structural changes):

- industry: iron and steel, chemical industry, non-ferrous metals, construction materials, pulp and paper, capital goods producing industry, other industries (except refineries);
- primary/tertiary sector: agriculture and fisheries, other commercial/public sectors;

- transportation: road, rail, and inland navigation;
- private households (residential sector): space heating, hot water, cooking, and electric appliances.

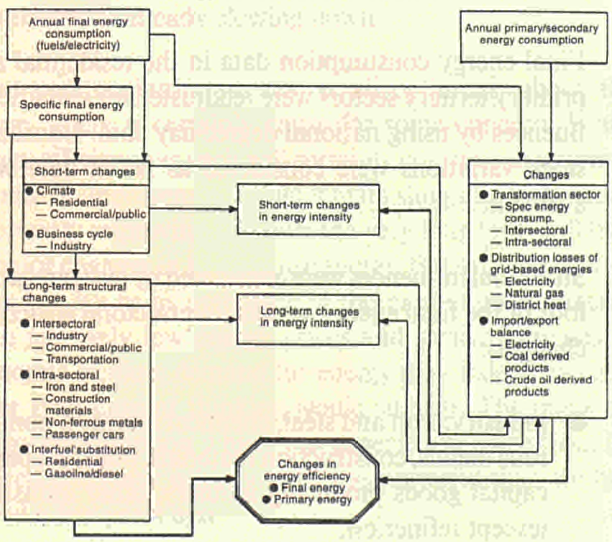
The effects of the intersectoral structural change between industry and the primary/tertiary sectors were also considered at the level of EUR 12.

(iv) Intersectoral changes, however, do not include the impacts of important structural changes in energy-intensive products and processes within the given industrial sectors (intra-industrial change). Therefore, some of the identified branches were further disaggregated into product groups or sub-sectors such as:

- steel (Thomas, Oxygen, Siemens-Martin, Electric Arc);
- primary aluminium and other non-ferrous metals;
- cement production and other construction materials.

(v) Finally, interfuel substitution was considered for space heating, hot water, cooking.

Fig. 2: Methodological concept on the analysis on energy conservation indicators



Source: Calculations by the Fraunhofer-Institute für Systemtechnik und Innovationsforschung (ISI).

The analysis of the energy transformation sector covered:

- structural changes in final energy outputs (electricity, gasoline, coke, etc.);
- Structural changes of transformation technologies (nuclear power, conventional thermal power, combined heat and power production);
- changes in energy efficiency of individual transformation technologies (fossil fuel-fired power stations, refineries, coke ovens, etc.); and
- changes in import/export balance of derived energy products (e.g. higher net imports of petroleum products); as well as
- changing distribution losses of grid-based energies.

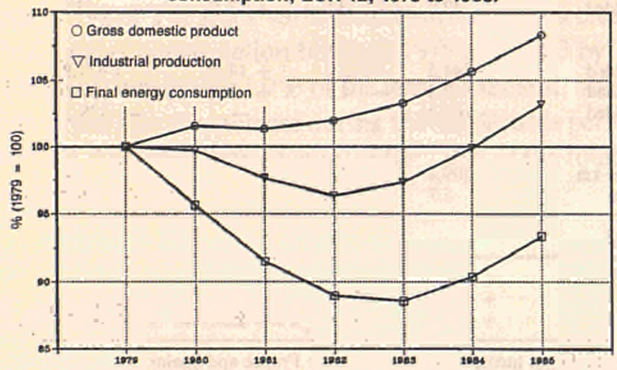
The data

Many of the data needed for the analysis have been taken from international (e.g. Cronos databank in Luxembourg, Unipede) or national official statistics. Missing data were collected from national sources such as trade associations, research institutions or single experts. In some cases, data which were not available on an annual basis were available at a high aggregation level, or data of time series had to be adjusted to statistical changes. Therefore, the authors asked nationally experienced institutions for assistance in collecting data and for reliable estimates for missing data. The problems of compatability and sometimes limited reliability of the national data for some sectors should be kept in mind when judging the results. However, the results are expected to be of reasonable quality. Comparing the two periods investigated, 1979/83 and 1983/85, the database changed in many member countries and sectors and, therefore, a direct comparison is not always possible.

Some background

Between 1979 and 1982 the increase in real energy prices and the economic stagnation accompanied by a recession of industrial production could be observed in the European Community (EC). This trend was true for all member countries with the exception of Denmark, Ireland (steady growth of industrial production), and Italy (beginning of the recession in the year 1981, ending in 1983). After 1982 the economy of the EC recovered, the gross domestic product (GDP) and the industrial production (IP) increased again. Due to these economic conditions the final energy consumption showed a falling tendency between 1979 and 1982 and an increase between 1982 and 1985 (see Figure 3).

Fig. 3: Indices of gross domestic product at market prices, general indices of industrial production and final energy consumption, EUR 12, 1979 to 1985.



Sources: Eurostat, Energy statistics yearbook, several editions.

Against the background of this development one has to quantify the contributions to the annual energy consumption attributable to economic growth, structural changes in the economy, particularly in industry and the residential sector, and to energy efficiency improvements due to technical or organizational measures or behavioural changes. Some of the contributions may be of a fairly constant long-term character, the others may periodically fluctuate. The following key findings are the results of an attempt to quantify this puzzle as far as possible, i.e. depending on the data availability and reliability and on the available funds.

The reference years for the analysis are 1979, 1983, and 1985 for all energy sectors except the electrical appliances in the residential sector. Because of lack of relevant data, the reference years for these items are 1979, 1982 and 1986.

Even now the story is not complete. There remains further sifting of the data to achieve a more accurate measure of energy efficiency. Yet even when this is achieved there will remain a time lag between current events and the availability of this type of detailed analysis. To overcome this, research attention is now focused on developing short-term indicators which will provide, albeit in a more aggregate form, information on current trends much earlier.

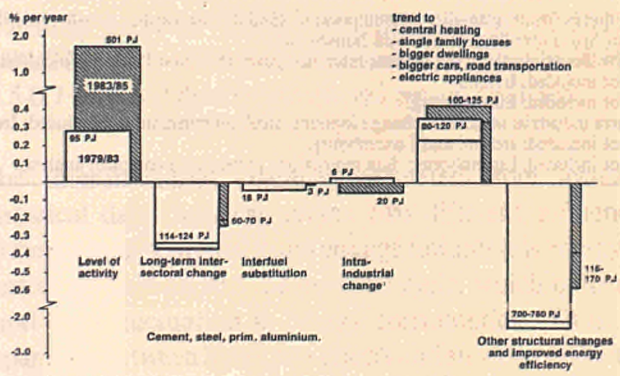
The key findings

The key findings for the final energy sectors and the transformation sector are summarized in the following sections.

Key findings — final energy sectors

From 1979 to 1983 the final energy consumption of EUR 12 (including non-energy consumption) decreased from 33 570 PJ (802 Mtoe) to 29 450 PJ (704 Mtoe). The average annual rate of decrease was 3.2% or 1 030 PJ/yr (approximately 25 Mtoe/yr). During the subsequent period (1983-85) an average annual increase of 2.7% could be observed (905 PJ/yr or 22 Mtoe/yr), culminating to a final energy consumption of more than 31 260 PJ (747 Mtoe). These variations in final energy consumption have to be broken down into their components in order to identify the effects of influencing factors and determine the trend of final energy efficiency on a long-term scale.

Fig. 4: Annual change in specific final energy consumption due to several factors, EUR 12, 1979 to 1985



Source: calculations by ISI

Weather

As the weather was rather cold in 1979 and warm in 1983 in most member countries, 466 PJ (11.1 Mtoe) of the decrease in final energy consumption was due to this effect (see Figure 5). Thus, the variation of the weather conditions induced 11.3% of the total consumption decrease between 1979 and 1983. During the subsequent period the opposite occurred: 530 PJ (12.6 Mtoe) of the increase in final energy consumption between 1983 and 1985 was due to colder weather in 1985 when compared with 1983 (see Figure 6). This amount represents 29% of the total increase in consumption.

Fig. 5: Aggregate indicators of the factors determining final energy consumption, EUR 12, 1979-83 (in PJ)

Sector	Final energy consumption 1979	Final energy consumption 1983	Difference 1979/83 explained by					
			Weather[1]	Level of activity		Intersectoral change	Interfuel substitution	Other factors incl. energy efficiency
Residential								
— space heating	5 802.6	5 171.0	—304.8	dwelling	+ 289.4	—	— 56.9	— 559.2
— water heating	1 026.1	1 058.2	—	capita	+ 15.8	—	— 5.8	+ 22.1
— cooking, etc.	461.3	436.8	—	household[2]	+ 20.5	—	—	— 45.0
— el. appliances[3]	429.9	455.1	—	household[2]	+ 16.4	+ 32.9	—	— 24.1
Agric./Comm./Public[4]								
— fuels	3 583.4	2 938.6	— 151.8	value added	+ 183.9	+ 31.2	— 17.0[5]	— 691.1
— electricity	849.9	966.8	— 9.5	value added	+ 47.7	+ 3.9	+ 7.5[5]	+ 67.3
— Manufact. industry								
— fuels	8 786.8	6 793.1	—	value added	— 244.5	—292.0	+ 14.6[6]	—1 471.8[7]
— electricity	2 038.9	1 931.4	—	value added	— 52.3	— 4.5	+ 7.9[6]	— 57.7
— non-energy consumption	3 025.6	2 597.0	—	value added	— 100.4	—	—	— 328.2
Transportation[8]								
— passengers	4 007.8	4 256.3	—	passenger-km	+ 209.4	+ 31.7	—	+ 7.4
— freight	1 955.1	2 002.5	—	tonne-km	— 5.7	+ 61.0	—	— 6.9
Sectors and countries not analysed	1 605.0	846.7		— 758.3				
Sum Final Energy Consumption								
— energetic consumption	30 545.1	26 872.5	— 466.1		+ 479.6	—135.8	— 49.7	—2 759.0
— incl. non-energy cons.	33 571.4	29 453.5	— 466.1	— 758.3	+ 379.2	—135.8	— 49.7	—3 087.2

[1] A minus means a smaller consumption in 1983 due to warmer weather in 1983 than in 1979 (data do not include climatic effects for France and Spain).
[2] For Spain dwellings rather than households.
[3] Five major electrical appliances; reference years 1979 and 1982; not included: Greece.
[4] Not included: Ireland.
[5] Not included: Luxembourg.
[6] Intra-industrial structural change (cement, steel, aluminium); not included: Ireland.
[7] Not included: Ireland and Luxembourg.
[8] Not included: Luxembourg; data restrictions prevented a complete analysis.

Fig. 6: Aggregate indicators of the factors determining final energy consumption, EUR 12, 1983-85 (in PJ)

Sector	Final energy consumption 1983	Final energy consumption 1985	Difference 1983/85 explained by					
			Weather[1]	Level of activity		Intersectoral change	Interfuel substitution	Other factors incl. energy efficiency
Residential								
— space heating	5 078.5	5 702.6	+409.9	dwelling	+ 134.7	—	— 10.1	+ 89.7
— water heating	1 188.0	1 206.4	—	capita	+ 5.4	—	— 4.5	+ 17.5
— cooking, etc.	447.8	452.1	—	household[2]	+ 13.4	—	—	— 9.1
— el. appliances[3]	433.2	504.9	—	household[2]	+ 15.3	+ 38.7	—	— 17.7
Agric./Comm./Public[4]								
— fuels	2 828.9	2 975.2	+ 109.4	value added	+ 156.8	+ 11.4	— 3.4[5]	— 127.9
— electricity	960.9	1 044.4	— 9.6	value added	+ 54.7	+ 0.2	+ 4.7[5]	+ 14.6
— Manufact. industry								
— fuels	6 860.7	6 928.4	—	value added	+ 270.8	— 12.4	— 36.5[6]	— 154.2[7]
— electricity	1 920.1	2 056.9	—	value added	+ 75.8	+ 34.5	— 3.9[6]	+ 30.4
— non-energy consumption	2 597.0	2 645.4	—	value added	+ 22.6	—	—	+ 25.8
Transportation[7]								
— passengers	4 119.2	4 240.1	—	passenger-km	+ 166.3	+ 7.0	—	— 52.4[8]
— freight	1 945.7	2 050.0	—	tonne-km	+ 87.7	— 0.9	—	+ 17.5[9]
Sectors and countries not analysed	1 073.0	1 456.1		+ 382.3				
Sum Final Energy Consumption								
— energetic consumption	26 872.5	28 313.2	+ 523.6		+ 980.9	+ 78.5	— 53.7	— 156.2
— incl. non-energy cons.	29 453.5	31 262.6	+ 523.6	+ 382.3	+ 1 003.5	+ 78.5	— 53.7	— 130.4

[1] A plus means an additional consumption due to colder weather in 1985 than in 1983 (data do not include climatic effects for France and Spain).
[2] For Spain dwellings rather than households.
[3] Live major electrical appliances; reference years 1982 and 1986 excepting for Netherlands, Portugal and Spain (1982/85); not included: Greece.
[4] Not included: Ireland.
[5] Not included: Belgium and Luxembourg.
[6] Intra-industrial structural change (cement, steel, aluminium); not included: Luxembourg.
[7] Not included: Luxembourg; data restrictions prevented a complete analysis.
[8] Net effect exclusively due to Italian contribution.
[9] Estimate corrected for Danish contribution.

Consumer stock variations

The analysis of the relevance of consumer stock variations in petroleum products and coal showed that multi-seasonal consumer stock changes appeared significant only for the Federal Republic of Germany and France. In other member countries there seemed to be only either seasonal or even shorter stock variations of fossil fuels for heating purposes (Shell, 1987). The stock variations reinforced the decrease in final energy consumption between 1979 and 1983 by 78 PJ (1.9 Mtoe) which was 1.9% of the total decrement, and they reinforced also the increase during the subsequent period by 50 PJ (1.2 Mtoe) which accounted for 2.9% of the total consumption growth.

Level of activity

The increase in the level of activity in the sectors analysed resulted in a total increase in final energy consumption during both periods (see Figures 5 and 6). As there was an economic stagnation and a recession in the manufacturing industry between 1979 and 1983, only the residential sector, the agricultural/commercial/public, and the passenger transportation sub-sector contributed to the increase during this period. Freight transportation was influenced by the manufacturing industry and showed the same declining trend. The additional energy consumption due to the increase in the activity level amounted to 380 PJ (9 Mtoe) or 95 PJ/yr (2.3 Mtoe/yr) on average (see Figure 5). This value is only 20% of the average annual increase in the subsequent period: 500 PJ/yr (12 Mtoe/yr) were observed (see Figure 6). The manufacturing industry and freight transportation contributed 457 PJ (10.9 Mtoe) to the total increase during this period of economic recovery.

Intersectoral changes

The structural changes between the primary and tertiary sectors, among industrial sub-sectors and among different types of transportation services induced a decrease in the final energy consumption between 1979 and 1983, but an increase during the subsequent two years.

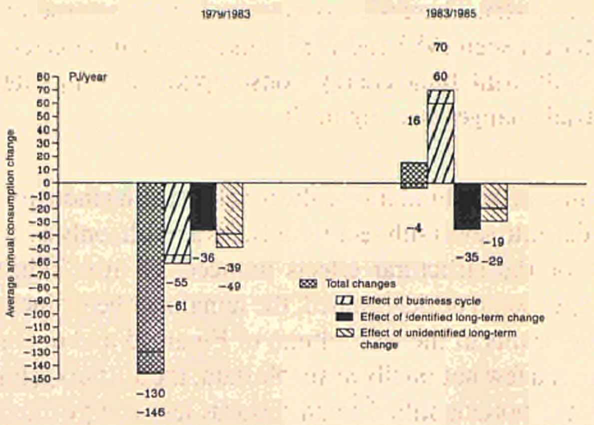
The reduction in final energy consumption of 135 PJ (3.2 Mtoe) during the first period can be attributed exclusively to the manufacturing industry. This can be explained by the fact that during the economic downswing the energy-intensive sub-sectors reduced their share of industrial production, and hence made an above-average contribution to the decrease in specific energy consumption. It was to be expected that during the following upswing period of the business cycle the same sub-sectors would contribute much above the average to the growth of the specific industrial energy consumption. This development was observed for the energy-intensive sub-sectors chemical industry and iron and steel industry. There was no recovery in the construction industry between 1983 and 1985; this resulted in a decrease in the industrial final energy consumption due to inter-industrial changes (see Figure 7).

Because of data limitations, the manufacturing industry was divided into seven sub-sectors only. As a result, only a certain part of the structural effects induced by inter-industrial changes could be determined, the remainder being included in the results in the last column of Figures 5 and 6. On the basis of a few nationally available data, the authors estimate that the non-identified trend towards less energy-intensive industries reduced energy consumption by 40-50 PJ/yr (1.0-1.2 Mtoe/yr) during the first period and by 20-30 PJ/yr (0.5-0.7 Mtoe/yr) during the second period analysed.

The inter-industrial changes calculated from available statistical data, however, reflect two different influences, namely a long-term structural change towards less energy-intensive production and the business cycle, which induces a short-term fluctuation in energy consumption. Thus, the separation between long-term effects and short-term fluctuations had to be made in order to determine the long-term trend. The results of this calculation based on the procedure described earlier (see Morovic *et al.* 1987) are presented in Figure 8. They indicate that the long-term trend towards less energy-intensive industrial structures was reducing the fuel consumption by 80-90 PJ/yr (1.9-2.2 Mtoe/yr) between 1979 and 1983, but at the same time increasing the electricity consumption by approximately 6 PJ/yr (0.1 Mtoe/yr) if the effects of identified (calculated) and non-identified (estimated) inter-industrial changes are taken into account. During the 1983/85 period the long-term trend seems to have weakened, reducing fuel consumption by 60-70 PJ/yr (1.4-1.7 Mtoe/yr), whereas the increase in electricity consumption apparently remained unchanged (6 PJ/yr; 0.1 Mtoe/yr).

In the first period the effects of the business cycle reinforced the reduction in fuel consumption by 48-53 PJ/yr (1.1-1.3 Mtoe/yr) and reduced electricity consumption by 7-8 PJ/yr (0.2 Mtoe/yr). The opposite occurred during the second period: the business cycle induced an additional energy consumption of 50-55 PJ/yr (1.2-1.3 Mtoe/yr) for fuels and 10-15 PJ/yr (0.2-0.4 Mtoe/yr) for electricity. Thus, the inter-industrial changes intensified the decrease in fuel consumption during the first period, whereas during the second period the long-term trend and the business cycle almost offset each other (see Figure 7).

Fig. 7: Inter-industrial structural changes and the influencing factors, EUR 12, 1979-85



Sources: Eurostat, *Energy statistics yearbook*, several editions.

In the transportation sector the intersectoral structural changes contributed to an increase in final energy consumption of approximately 23 PJ/yr (0.6 Mtoe/yr) between 1979 and 1983. This trend was characterized by a shift of rail and public transportation in cities to road transport. In the subsequent period this trend could be observed only in the passenger transport sub-sector, but reduced to an average value of 3.5 PJ/yr (0.1 Mtoe/yr) which represents only 15% of the value for the previous period. Another structural effect, namely the trend to bigger cars, was calculated only for the period 1983/85 and only for six member countries, resulting in an increase of 17 PJ/yr (0.4 Mtoe/yr). Since there was a trend to smaller cars in France, Italy and Spain, which were not included in the calculation mentioned above, the authors estimate this structural effect to be 12 to 15 PJ/yr (0.3 to 0.4 Mtoe/yr) for EUR 12. This effect, however, is included in the last column of Figure 7.

The structural effect within the residential sector could be analysed directly for the electrical appliances only. It was defined as a growing penetration of six major electrical appliances per household (refrigerator, freezer, washing machine, dryer, dishwasher, and television) and was responsible for an increase in electricity consumption in this sub-sector of approximately 10 PJ/yr (0.2 Mtoe) during the whole period 1979 to 1986. There are three more structural effects in the residential sector which can be calculated separately or estimated on the basis of a few nationally available data: the shift towards central heating and single family houses and the increase in the average floor area per dwelling. In Figures 5 and 6 all these effects are included in the column 'other factors including energy efficiency'. For the period 1979 to 1983 all the effects had to be estimated due to a lack of reliable data, whereas for the subsequent period the shifts towards central heating and single family houses could be calculated. For the first period the authors estimated a net effect of 70-90 PJ/yr (1.7-2.2. Mtoe/yr) additional energy consumption for space heating purposes. This estimate seems to be confirmed by the calculations for the subsequent period, which showed an additional energy consumption for space heating of 85-105 PJ/yr (2.0-2.5 Mtoe/yr). This is also in accordance with the accelerated shifts towards central heating and single family houses and the increase in average floor area per dwelling during the second period, which can be traced back to the increase in real income of private households in almost all member countries since 1983.

Intra-sectoral structural changes in industry

The effect of intra-sectoral structural changes has been analysed for three energy-intensive industrial sectors (e.g. construction materials/cement, iron and steel industry/types of steel production processes, non-ferrous metals/primary aluminium). The increase in the energy consumption caused by this effect between 1979 and 1983 was dominated by the trend towards industrialization in Spain and Portugal (see Figure 5). The reduction in final energy consumption between 1983 and 1985 of 40 PF (1 Mtoe) can mainly be attributed to developments within the construction materials sector: the energy-intensive cement production became less important in comparison with the production of less energy-intensive product groups in this sector (see Figure 6), energy-intensive cement production declined much more than the production of less energy-intensive product groups (see Figure 6).

Interfuel substitution

In both periods interfuel substitution in the residential and agricultural/commercial/public sectors contributed to a reduction in energy consumption. The trend towards substituting heating oil and coal by gas, district heating, and electricity with higher conversion efficiencies at the final energy level was significant between 1979 and 1983: an average annual contribution of 18 PJ/yr (0.4 Mtoe/yr) was achieved (see Figure 5). From 1983 to 1985 this trend slowed down to 6.6 PJ/yr (0.2 Mtoe/yr) (see Figure 6). These reductions of the consumption at the final energy level, nevertheless, were responsible for additional primary energy consumption in the transformation sector, particularly for electricity production and distribution losses.

Other factors including energy efficiency

Available data for EUR 12 did not permit complete separation of the effects of more rational energy use from other effects due to structural and technical changes not analysed. Some of these effects, such as the trend towards central heating, single family houses and bigger dwellings could be estimated, as already stated above. Some other effects such as driving behaviour, changes in heating habits (behaviour-induced effects) could not be explicitly identified or estimated.

The estimates mentioned above changed the calculated values attributed to 'other factors including energy efficiency' in Figure 6 from an average annual value of 770 PJ/yr (18.4. Mtoe/yr) to 795-850 PJ/yr (19.0-20.3 Mtoe/yr) between 1979 and 1983. However this figure includes a contribution due to the intersectoral change between the industrial and the agricultural/commercial/public sectors, which reduced the final energy consumption by 80 PJ/yr (1.9 Mtoe/yr). As a result the authors assume a net annual reduction in final energy consumption of 700-760 PJ/yr (16.7-18.2 Mtoe/yr) due to improved energy efficiency as well as some other minor important effects.

In the subsequent period, the same procedure yielded the following result: taking into account the effect already estimated (see **Intersectoral changes,** page 58), the reduction in final energy consumption amounts to 150-205 PJ/yr (3.6-4.9 Mtoe/yr) rather than 70 PJ/yr (1.7 Mtoe/yr). The contribution induced by the intersectoral changes between the industrial and agricultural/commercial/public sector is included in this figure with an amount of 35 PJ/yr (0.8 Mtoe/yr).

Thus, the net annual reduction in final energy consumption between 1983 and 1985 amounted to 115-170 PJ/yr (2.7-4.1 Mtoe/yr) due to improved energy efficiency and some other minor important effects. This result shows that the improvement in energy efficiency experienced a rigorous drop reducing the final energy consumption by an amount which is only 17-22% of that observed in the previous period. This result is not surprising, since this change was brought about by several factors:

(i) In real terms, fuel prices were slightly falling in most member countries since 1982 and, hence, fuel price expectations changed from 'most likely to increase' to 'stable' or even 'slightly falling'. In many cases, attention to energy saving investments declined because of these changing price expectations.

(ii) Increasing real income and reduced energy costs due to more rational energy use were used to increase comfort, as measurements on indoor temperatures in Denmark and the United Kingdom demonstrate.

(iii) The potential of quick, very profitable investments in improving energy efficiency may have been exhausted in many sectors before 1983. Since then, energy conservation investments have had longer payback periods and lost priority in decision making.

(iv) The lack of awareness of energy consumers reinforced governments to reduce efforts for a more rational energy use because it was no longer a political issue, and budgetary arguments have been put forward in order to justify reduced activities in energy demand policy.

(v) Additional energy supply of coal, oil, and gas as a mid-term reaction on the price increases of crude oil in 1979/80 appeared on the world market since 1983, and in most member countries overcapacities of electricity generation grew because of unrealistically high demand projections made in the 1970s.

In the light of the slowdown of the energy efficiency improvements since 1982/83, the authors raise the question whether governments should, under present conditions, pursue a counter-cyclical energy demand policy in order to get more social benefit in the long run.

Key findings — transformation sector

From 1979 to 1983 the energy input of the transformation sector of EUR 12 decreased from 43 220 PJ (1 032 Mtoe) to 35 830 PJ (856 Mtoe). Compared with the average annual rate of decrease of the final energy consumption (3.2% per year, the achieved average annual decrease of 4.6% per year seems to indicate an improvement in overall energy efficiency (a ratio between final energy consumption and primary energy consumption). But if the net foreign trade balance in derived energy products is taken into account, the total primary energy (TPE) consumption experienced a decrease of only 2.4% per year on average. This significant difference in decrease rates is due to the fact that EUR 12 was a net exporter of derived energy products in 1979, whereas in 1983 it was a net importer.

Between 1983 and 1985 the energy input in the transformation sector increased by 1 275 PJ (30.5 Mtoe) 1.8% per year of the input for 1983), and the increase in net imports of derived energy products showed almost the same amount: in 1985 some 943 PJ (22.5 Mtoe) more were imported than in 1983.

Level of activity

The level of activity indicated by the net energy output of the transformation sector, which reflects the final energy demand (except natural gas), induced a significant drop in the TPE consumption of approximately 10 255 PJ (254 Mtoe) between 1979 and 1983. This figure corresponds to an average annual decrease rate of 6.4% of the TPE consumption for 1979. The changes in foreign trade in energy derived products were hardly influenced by the level of activity, and the impact of the level of activity as a whole can almost exclusively be attributed to the transformation sector (see Figure 8).

During the subsequent period the growing final energy demand induced a growing net energy output in the transformation sector. This resulted in an additional primary energy input in the transformation sector of 560 PJ (13.4 Mtoe) due to the increasing level of activity. TPE consumption increased by 0.7% per year. The increasing demand for final energy also stimulated an increasing import of derived energy products. In this sector the level of activity increased the TPE consumption by 46 PJ (1.1 Mtoe). This amounted to 7.6% of the increase due to the level of activity as a whole (see Figure 6).

Fig. 8: Aggregate indicators of factors determining the total primary energy consumption, EUR 12, 1979-83 (in PJ)

Sector	Energy consumption 1979	Energy consumption 1983	Difference 1979/83 explained by: Level of activity		Inter-sectoral change	Other factors incl. energy efficiency
Transformation sector	43 223.0	35 832.8	net energy output	−10 255.6	+3 068.9	− 203.5
Net imports of derived prod.[1]	− 317.8	702.1	total primary energy +	28.9	+1 145.1	− 154.0
Others[2]	1 522.1	3 843.7	+2 321.6	n.a.	n.a.	n.a.
Total	44 427.3	40 378.6	+2 321.6	−10 226.7	+4 214.0	− 357.5
Distribution losses	659.2	733.3	distributed energy −	9.3	n.a.	+ 83.4

[1] A minus means net exports.
[2] Other sectors not concerned e.g. net imports of natural gas.
n.a. not analysed.

Intersectoral changes

The changes in shares of the transformation sub-sectors in the total output of the transformation sector, and the changes between domestic transformation and net imports of derived energy products gave rise to a significant growth of TPE consumption in both periods. The average annual increase between 1979 and 1983 was 2.3% per year of the TPE consumption for 1979, totalling approximately 421 PJ (100 Mtoe) over the period of four years. During the subsequent period this rate remained unchanged (see Figures 8 and 9).

The intersectoral changes in the *transformation sector* are essentially due to a continuously growing share of electricity generation by thermal and nuclear power plants and to the declining share of petroleum products in the total output of this sector. Thus the share of refined oil products in the total output decreased from 74.8% in 1979 to 67.2% in 1985. During the same period electricity gained six percentage points, totalling a share of 18% in 1985. The main contribution came from nuclear power plants, which increased their share from 1.5% to 6.3% in the transformation sector.

Fig. 9: Aggregate indicators of factors determining the total primary energy consumption, EUR 12, 1983-85 (in PJ)

Sector	Energy consumption 1983	Energy consumption 1985	Difference 1983/85 explained by: Level of activity		Inter-sectoral change	Other factors incl. energy efficiency
Transformation sector	35 832.0	37 107.1	net energy output	+ 560.5	+ 942.3	− 228.6
Net imports of derived prod.[1]	702.1	1 645.1	total primary energy	+ 46.2	+ 970.3	− 73.5
Others[1]	3 843.7	4 295.1	+ 451.4	n.a.	n.a.	n.a.
Total	40 378.6	43 047.3	+ 451.4	+ 606.7	+1 912.6	− 302.1
Distribution losses	733.3	765.9	distributed energy	+ 38.2	n.a.	− 5.6

[1] Other sectors not concerned e.g. net imports of natural gas.
n.a. not analysed.

Growing net imports in *derived energy products* (petroleum products, coke and electricity) reinforced the structurally induced increase in the TPE consumption to a large extent. During the first period they contributed 37% and during the second period more than 50% to the total effect induced by structural changes. These changes originated exclusively from steadily increasing imports of petroleum products. Starting as a net exporter in 1979, EUR 12 became a net importer already in 1980 and more than doubled its net imports within the two-year period between 1983 and 1985. The main sources of the petroleum products were the OPEC countries and the USSR.

Other factors including energy efficiency

As was the case with the final energy demand sectors, it was not possible to differentiate between two effects; improved energy efficiency, i.e. more rational use of energy, and other structural changes not further identified (e.g. capacity and load changes within different sub-sectors, changing output structures of petroleum products, changes in the operation of transformation facilities). There is some evidence, however, that the effects of non-identified structural changes were of minor influence. Thus, the improvement in energy efficiency was small. The average annual decrease in the TPE consumption due to improved energy efficiency and other factors such as a changing share of imported derived energy products in TEP consumption was 0.2% per year between 1979 and 1983 and approximately 0.4% per year during the subsequent period.

The conclusion of the analysis is that improvements in energy efficiency played a negligible role in determining the TPE consumption during the whole period analysed.

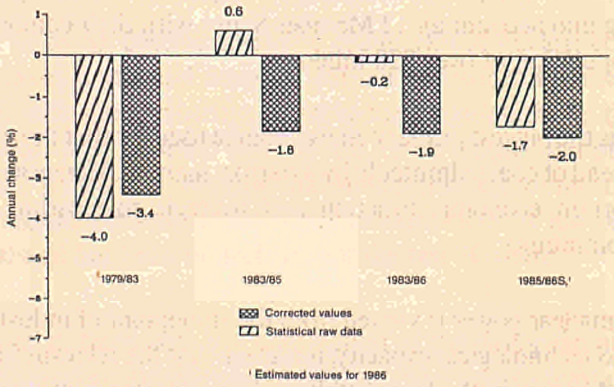
Distribution losses of grid-based energies

The increasing demand for grid-based energies (electricity, natural gas, and district heating) increased the transportation and distribution losses. Although many old grids were repaired or replaced especially during the second period analysed, a steady increase in specific losses was observed (1979: 5.1%; 1985: 5.7%).

Conclusions

Although the improvement in energy efficiency could not be separated from some minor important structural effects, there is no doubt that the energy savings achieved were reduced significantly during the period 1983/85. The average annual contribution of 115-170 PJ/yr during the second period was only 20-25% of the amount per year achieved between 1979/83. The difference between approximately 2.2% per year during the first period and approximately 0.5% per year during the second period was due to several factors (see Figure 3): falling fuel prices extended the pay-back periods of many fuel conservation investments. Increasing real income enabled private households to revert to their former heating and driving behaviour: the trend towards more comfort resulted in higher indoor temperatures, larger heated areas, and less energy-conscious driving habits. Thus, it can be assumed that in 1985 consumers returned to a 'normal' behaviour after a period of restricted living standards. Furthermore, the potential of quick, highly profitable energy saving investments which had been made first in 1980 to 1982 was gradually exhausted, and investments with longer pay-back periods had to compete with other investments. Finally, the new energy supplies met a shrinking energy demand so that overcapacities developed in most energy supply sectors and member countries. Consequently, energy conservation lost its role as a major political issue, and energy conservation programmes were terminated in many sectors and member countries by 1984/85.

Fig. 10: Changes in final energy intensity for EUR 12 from 1979 to 1986, corrected for weather fluctuations and structural effects due to the business cycle.



Source: Calculations by ISI.

If the statistical raw data are adjusted for short-term fluctuations, the intensity of final energy of EUR 12 declined by 2.0% between 1985 and 1986 (see Figure 10). So the first year was in line with the goal set by the Council of the European Communities in 1986. But if the current trends of declining structural changes to less energy-intensive production and of increasing levels of energy-consuming comfort in the domestic and private transportation sectors prevail in the years to come, the authors doubt that the goal of the Council, i.e. a 20% decrease in intensity of final energy between 1985 and 1995 can be reached. The scepticism would change if the member governments would initiate a revival of a convincing energy conservation policy to reduce existing obstacles and market imperfections, and to take into consideration the external benefits resulting from a more rational use of energy.

Nuclear energy: the challenges of the future — the case of the European Community

At the request of the Société française d'énergie nucléaire (French Nuclear Energy Society) (SFEN), Jean-Claude Charrault, the Head of Nuclear Policy Division of DG XVII, reviewed the challenges facing nuclear energy in the European Community at a symposium on nuclear energy held in Paris on 14 June 1988. Mr Charrault's presentation is reproduced below.

'As you all know, we are on the eve of completion of the large European market, which is both the next stage in building a united Europe and a springboard for reviving the European ideal.

Energy will form an integral part of that market without internal frontiers: it is therefore legitimate to wonder where nuclear energy stands in relation to the new situation that will be created from 1992.

In other words, what contribution can nuclear power make to Europe's future?

At the present time, nuclear power accounts for some 35% of electricity production in the European Community, taking into account all 12 Member States with their combined population of over 320 million.

It is the biggest primary energy source used for that purpose, ahead of coal (admittedly by a narrow margin). Hence its important economic function and strategic role within the Community.

If nuclear power is viewed from the standpoint of industrial and technological capacity, it is clear that the relevant firms and bodies in the Community, taken as a whole, master all the specializations necessary for harnessing this source of energy; they are also at the forefront of technical development, including advanced concepts.

I am thinking in particular of fast breeder technology, which is now approaching maturity and competitiveness; we could even go so far as to say, taking as a unit of measurement the time constant of energy systems, that such maturity and competitiveness is only two steps away. Continuing in the same vein, we could also say that we need one more step to test the system and another one to prepare series construction.

Thus for the European Community and nuclear power, the challenges of the future are:

(i) a large market without internal frontiers in which nuclear power has already acquired an important position, but there are still considerable possibilities for penetration in the electricity production sector;

(ii) a capable and self-sufficient industry and a technology enabling nuclear power to be transformed into an indigenous and (almost) renewable energy source; and, I would also add here, the possibility of preserving air quality, since the bulk of the harmful waste produced by nuclear power is kept confined.

Challenges can be fought and won, as we all know, but they can also be lost.

There are indeed plenty of difficulties:

on the one hand:

(i) of the 12 Community Member States, five do not use nuclear power, while of those that do, there are some whose future commitment to nuclear power has been called into question. European public opinion is recovering only very slowly from the trauma of Chernobyl;

(ii) opinion polls conducted by the Commission six months after the accident revealed that 55% of the population considered nuclear hazards to be unacceptable; 50% still held that view at the end of 1987, whereas in the three surveys carried out before the accident (in 1978, 1982 and 1984), the proportion of public opinion taking that view never exceeded 38%;

on the other hand:

(i) it is undoubtedly satisfying to note that the nuclear fuel industries have a capacity, structure and market position that do not pose any acute problem from the technological and economic standpoints;

(ii) it also has to be recognized, however, that the nuclear power station design and construction industries are highly fragmented, while the market opportunities at European and world level, in terms of the number of units ordered each year, are limited, even in the long term;

such a situation is far from ideal, even if certain firms have been successful on export markets.

Faced with Member States whose options with regard to nuclear power are so far apart and a public that has to some extent lost faith — perhaps only temporarily — in nuclear power, can one speak of a "common nuclear policy"?

I, for my part, believe that the aspects of such a policy exist and are slowly but surely falling into position.

In the first place, the Euratom Treaty clearly indicates a need for cohesion in the Community with regard to nuclear power.

Secondly, the internal market must be completed in the field of energy and energy plant.

Lastly, desirable developments must be encouraged wherever possible.

Here is an example of the efforts made to maintain cohesion.

On 31 May 1985, the Commission of the European Communities proposed energy objectives for 1995 which included the aim of producing 40% of all electricity in the Community from nuclear power.

Discussions within the Council of Ministers ran up against the difficulty of reaching a consensus on a quantified target for nuclear power. Such discussions had not been completed when the Chernobyl accident took place; the Council finally adopted its resolution on 16 September 1986.

The objective for nuclear power is not specified in the resolution, but can be deduced from the fact that a limit of 15% is placed on the contribution of oil and natural gas to electricity production.

To underline this, the resolution mentions the large share taken by nuclear power in the Community's energy supplies.

Community cohesion was thus preserved, even if only on a narrow basis; at the same time, the role of nuclear power in generating electricity was recognized as being important in the Community.

Other examples could be given, but the fact remains that greater cohesion and a broader consensus would be desirable.

Establishment of the internal market in energy requires a considerable amount of groundwork, which has been set in hand and will continue through discussions with the sectors concerned. It is too early at this stage to predict how the common market in electricity will in the final analysis be organized.

There are many complex problems to be solved, and it is in the interest of all concerned that they should be studied thoroughly before deciding on any solutions. Once the latter have been adopted in the appropriate forms, electricity should be able to flow more freely throughout the Community. Nuclear power will thus have greater access to its potential market in Europe and will also improve the security of supply.

The general aim of the large internal market in energy is to reduce costs and increase the competitiveness of the different sectors.

With that end in view, the Commission has undertaken, amongst other things, to introduce appropriate legislation laying down procedures for the award of works and supply contracts.

But let us not deceive ourselves: the market in nuclear construction works and supplies will not be opened up easily even with the application of procedural legislation. At the present time, national markets are, to all intents and purposes, walled off; transnational subcontracting within the Community relates to very small amounts (only a few percent) and has been in decline over the last 10 years.

It is as if, faced with the contraction of the European and world market, suppliers and their customers were endeavouring to strengthen their links on a national basis, whereas surplus production capacity should instead be encouraging the construction industry to aim for structural simplification and technical rationalization. Moreover, fear of seeing large manufacturers from outside the Community mounting an attack on our market and taking over our industry branch by branch or country by country, which is perhaps still only a potential threat, should also play its part in prompting the European nuclear industries to cooperate.

This means that the opening-up of national markets is the solution to a problem that extends far beyond the establishment of a European economic area: the very survival of the European nuclear industry.

That is why the opening-up of national markets will need to be a result of structural changes in the industry itself, not the opposite.

If we had to convey the fact by means of a slogan, we would couch it in the following terms: "one market, one product, one industry", in other words, an open European market, a product conforming to unified technical requirements and a single industry in order to place such a product on the market.

A document dating back to 1984 and entitled "Nuclear industries in the Community" sets out the Commission's view. This document, on which the Community's Economic and Social Committee delivered a favourable opinion, is better known under its subtitle, namely the "Illustrative nuclear programme" (or, simply, "the Pinc").

In the section on nuclear power station construction, the 'Illustrative nuclear programme' acknowledges that nuclear power will henceforth be developed mainly on the basis of PWRs and FBRs and stresses that such uniformity is likely to increase the technological understanding of the reactor concepts in question and strengthen still further the confidence already placed in them. It also stated that an essential aspect of the strategy to be followed is the establishment of common design and construction rules. Then, having noted that the nuclear industry will have to adapt itself to a situation of general surplus production capacity, the "Illustrative nuclear programme" draws the following conclusion (the passage being brief, I will quote it *in extenso*):

"As regards the FBRs, it seems that the present situation is favourable to the setting-up of an industrial structure, the style and capacities of which would be commensurate with the needs of the European market. As has been the case with the construction of Superphénix, there will be opportunities for those particularly qualified firms in all the countries involved.

The industrial rationalization required does not necessarily have to result in an integrated structure, but neither should it reject such a possibility from the outset.

In any case it should result in the creation of a true common market in FBRs, even though, at present, certain Member States are not seeking to construct reactors of that type on their territories.

It is most desirable that the rationalization in question, the object of which is to provide the industry concerned with the construction of FBRs in the Community with an appropriate structure, should not be restricted to that particular sector. It should also take account of the PWR sector and rationalize it. Difficult though this task may be, it will have to be accomplished sooner or later."

This viewpoint, which was adopted in 1984 and formally published in 1985, has not been proved wrong by subsequent events; on the contrary, it can only be confirmed today.

How can implementation of the strategy described be assisted?

In the "Illustrative nuclear programme", the Commission basically proposes two goals:

(i) the production of 40% of all electricity from nuclear power by 1995; and

(ii) the attainment of economic competitiveness for FBRs by the year 2005.

I would like now to give you two illustrations of specific instances in which the Commission has taken action to support implementation of the strategy.

First example of Commission involvement

When Superphénix was about to start up, the press was echoing a number of questions: "the energy market is slack, thermonuclear fusion is just around the corner, so are not fast reactors superfluous? ..."

We therefore retorted that the first oil shock took place at a time when energy was in abundant supply.

We also stated that fusion was a tremendous technological challenge, that work on fusion was a shining example of European coordination and worldwide cooperation, that it was an exceptional project around which basic research had to be focused and organized in order to make it as fruitful as possible, but that we were still too remote from mass energy production in order to base an energy strategy on such a potential source, even in the very long term.

We found it a strange thing indeed that the resource offered by fast reactors, which in fact consume only a few tonnes of depleted uranium per gigawatt per year, should arouse so many misgivings.

We felt that Europe, which imports half of its fossil fuel requirements and three-quarters of the uranium it consumes and is watching its stocks of depleted uranium grow at a rate of more than 10 000 tonnes a year, should on the contrary be welcoming the prospect of being able to produce electricity without depending on imports.

Then we heard the cry: "fast reactors are too expensive!"

Critics were in fact comparing the cost of the first large-scale prototype, built as an experimental international cooperative venture, with that of the 45th PWR built and put into service in France!

That prompted us to request the designers and builders of Superphénix to evaluate, under a study contract, the cost of the same reactor in different hypothetical circumstances that made it possible to deduct the additional costs resulting from the fact that it is a prototype and incorporate the effects of series construction, in order to be able to make a more meaningful comparison with a PWR station.

These calculations reduced the cost considerably — by as much as 45%.

If it was to be credible, however, such a result had to be validated by the potential customers for FBR power stations, namely the electricity utilities. We therefore requested a specialized working party of Unipede to assess the study. It did so with great thoroughness and approved the main lines of the method and results of the study.

The Commission helped in this way to clarify the debate on the economic aspects of fast reactors. (See also the article "Economics of building fast breeder reactors" in *Energy in Europe* No 9).

Beyond the design, technology and industrial organization that formed the basis of Superphénix, a potential for economic progress still remains to be tapped. That is the aim of the present phase in the development of the fast reactor concept, which leads me to my second example of the Commission's involvement.

Second example

The Commission welcomed the conclusion, on 10 January 1984, of the intergovernmental agreement between Belgium, the Federal Republic of Germany, France, Italy and the United Kingdom, establishing and organizing close cooperation with a view to developing fast reactors.

At the beginning of 1987, having noted that implementation of the agreement was losing steam, we proposed that the design and construction firms in the five countries concerned carry out together, under a study contract with the Commission, a comparison of the three FBR power station projects they were developing in parallel (namely SPX2, SNR2 and CDFR).

We asked them to present in comparable form the different options and their justification, then take stock of the similarities and differences between projects and finally to sketch out solutions that would enable those differences to be overcome.

We, for our part, made award of the contract subject to only one condition: we wished to deal with a single contractor authorized to speak on behalf of all the industrial firms involved.

Agreement was reached on the principle of the study and the text of the contract within a matter of weeks; however, conclusion of the contract took several months, the time necessary for the partners involved to settle between themselves the arrangements for their cooperation.

It was an extremely fruitful period, since the firms concerned did not have the impression that they were working against the clock or under pressure from an impatient client and were thus free to conduct their internal negotiations until they arrived at an efficient working structure.

At the end of 1987, once the contract had been signed, the groundwork completed and the project itself set well in hand, the association thus set up was able to offer any electricity utilities interested the main lines of a coherent set of options for an FBR project that will foreshadow the single model to be developed in Europe.

Our involvement, which boiled down to giving a push in the right direction at the right time, undoubtedly made it possible to gain a considerable amount of time in laying the foundations for the future.

The FBR development strategy so far involves only five of the Community Member States.

Ensuring cohesion between the Member States is one of the most important tasks of the Community's Fast Reactor Coordinating Committee. All Member States have the right to be represented on that Committee, through their administrations and research institutes and the industrial operators concerned.

Such cohesion is cemented by the provision of information and, above all, efforts to explain the factors and processes involved.

At the same time, on its own initiative, the European Parliament periodically reviews the status of and prospects for FBR development and delivers an opinion after taking note of the views of all the parties concerned, including the Commission. Mr Seligman (who addressed the symposium earlier) is currently the Parliament's draftsman for such matters.

Mr Chairman, ladies and gentlemen, I have come to the end of my talk.

I have endeavoured to show you what are the future challenges facing nuclear power in the European Community:

(i) the potential market is large, and a common market in electricity will certainly increase this potential;

(ii) a single product, in other words, a single reactor model for each concept (therefore both the PWR and the FBR), based on the best available technology and offered by a single group of designers, stands the best chance of penetrating such a market, withstanding competition from outside the Community and holding its own against such competition on the export front.

It is also necessary, however, to strengthen public confidence in the safety of nuclear power.

I mentioned briefly, at the beginning of my talk, the series of public opinion polls we have carried out over the last 10 years. The perception of nuclear risk revealed by such surveys is deeply rooted in the human consciousness, as can be seen from the fact that, even under the shock of the Chernobyl accident, which exacerbated the public's fears of nuclear power stations exploding, the "dangers involved in the storage of radioactive waste", according to the words used in the questionnaires themselves, have always been those feared most by European public opinion.

But there is, of course, also a growing perception of the potential and actual damage to the environment attached to other forms of electricity generation — and of the need for solutions which take account of these concerns.'

Cooperation with China on natural gas — the Shan-Gan-Ning Basin

For several years the Community has been cooperating with non-Community countries on energy projects. An earlier issue of *Energy in Europe* described various aspects of this policy, particularly the close ties with China, where several energy planning projects have been completed.[1]

In 1985 a new dimension was added to this programme in the form of cooperation on natural gas prospecting and production technology.

Gas production in China

The 1980s saw a determined campaign by the People's Republic of China to boost its total primary energy production. As a result, in 1984 China produced 766 million tonnes of coal equivalent [2] and 2.3 million barrels of oil a day, to place it sixth in the world oil production rankings.

Coal and oil remain the two leading sources of energy supplies, with coal providing 70% of the primary energy which China needs and oil 20%. Natural gas, though, provides a modest 3%.

Chinese delegation visits the Groningen gas production centre.

This underexploitation of natural gas, which is produced almost exclusively from the Sichuan field, combined with the promising signs detected during prospecting in other regions prompted the Chinese authorities to make development of the country's gas resources one of the priorities of the seventh five-year plan adopted in 1986.

The Shan-Gan-Ning Basin

The Shan-Gan-Ning Basin extends over an area of 320 000 square kilometres in the bend of the Yellow River some 400 kilometres north of Xian. Oil has been produced in the region for 30 years or so. Over the last few years gas has been struck, with some wells producing 160 000 cubic metres a day during testing.

Geologically, the area is a vast syncline with an overthrust fault zone on its western flank. Much of the basin is covered by a thick layer of loess, producing the typical geomorphology of a plateau dissected by deep, irregular valleys.

Prospecting and production will be handled by the Changqing Petroleum Exploration General Company, which employs 50 000 workers and owns prospecting capacity including large seismic teams and a number of drilling sets.

Gas from the Shan-Gan-Ning Basin could supply Xian, a major industrial centre with a population of over 4 million, and the three densely populated provinces of Shaanxi, Gansu and Ningxia as such development would entail heavy investment in pipelines and storage and processing facilities.

Progress on the project

In 1985 the Chinese Minister for Oil contacted the Commission to propose extensive cooperation on gas prospecting in the Shan-Gan-Ning Basin.

Talks continued throughout 1986 and 1987. Commission officials visited China and Chinese experts came to European businesses, universities and research institutes with natural gas know-how to draw up a cooperation programme.

In 1988 it was agreed that the first experts would be sent in September to work on the preparatory data acquisition phase

1 See *Energy in Europe* No 3, December 1985.
2 *Pétrole et entreprise*, August 1985.

and to assess the technologies required. This will be followed by the two main implementation phases, which will last three years.

Details of the project

The Shan-Gan-Ning Basin cooperation project is concerned with the technologies for prospecting and developing the gas field, i.e.:

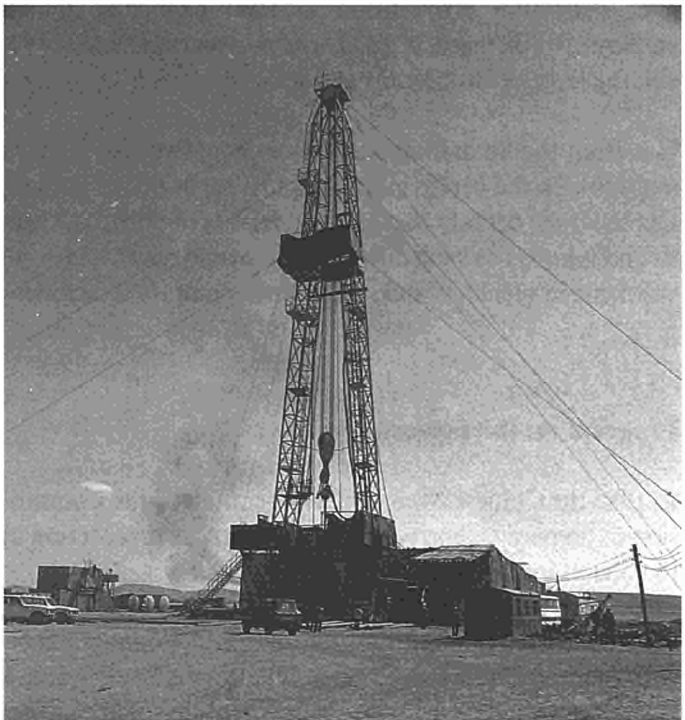
(i) geological exploration and modelling of the basin;

(ii) seismic geophysical exploration;

(iii) drilling, well-logging and well-testing;

(iv) resource appraisal and development.

The cooperation will take the form of joint appraisals and studies by Chinese and European experts plus training for Chinese technical staff.



Chinese drilling rig.

Preliminary estimates put the project cost at ECU 2.5 million. A large proportion (about 65%) would be funded by the Community and the governments of certain Member States and the remainder by the Chinese authorities. The project will be managed jointly by the Commission (Directorates-General VIII and XVII) and by the Changqing Petroleum Exploration General Company.

The Shan-Gan-Ning Basin cooperation project is the largest so far between the Community and the People's Republic of China and the first on oil and gas prospecting and production technologies.

The project will provide a vehicle for transferring technology from the Community to China. It will present European firms with an opportunity to apply technologies which they have developed. Most important of all, however, the programme could expedite expansion of the Chinese gas industry and thus improve China's energy supplies.

The Transnuklear-Mol affair

On 22 June 1988 the Committee of Inquiry set up by the European Parliament to investigate the movement of radioactive waste between the Centre for Nuclear Studies and Waste Treatment (CEN/CSK) in Mol, Belgium and Transnuklear GmbH in Hanau, FRG tabled its report.

Following the debate on the report at the European Parliament in Strasbourg on 5 July, the Parliament passed a resolution based on the report's findings which:

1. Calls for nuclear waste to be conditioned as far as possible at its point of origin and movements reduced to a minimum;

2. Calls for a clear division of responsibilities in waste management between the operation of nuclear installations, transport and conditioning;

3. Calls on the Commission to exercise fully its existing rights and, in particular, to take the following urgent measures:

   (a) draw up comprehensive Community rules on the transfrontier transport of nuclear waste, where such movements are unavoidable,

   Endorses the individual proposals put forward by the Committee of Inquiry to make transfrontier movements subject to a system of strict controls and authorizations from their point of origin to their point of storage,

   (b) draw up a regulation on radiation protection for temporary and part-time workers in the nuclear sector in conjunction with the European Trade Union Confederation,

   (c) exercise fully its inspection rights with regard to the implementation by the Member States of basic radiation protection standards and their monitoring of radioactive discharges into the environment,

4. Repeats, in addition, its call for a revision of the Euratom Treaty giving the Community clearer and more comprehensive powers in the sphere of nuclear safety, in particular the protection of health and the environment;

5. Takes the view that an expansion in the production and processing of plutonium will give rise to serious problems with regard to safeguards;

6. Stresses the important monitoring role played by Euratom and its inspectors in preventing diversions of fissile material;

7. Concurs, therefore, with the conclusions of the Committee of Inquiry that a series of measures are needed to increase the credibility and effectiveness of the safeguards, in particular:

   (a) hiving off the Safeguards Directorate from Directorate-General XVII, which is responsible for the promotion of nuclear energy,

   (b) an increase in the number of inspectors,

   (c) more frequent unannounced inspections,

   (d) improved protection against the manipulation of data by third parties,

   (e) make all radioactive waste falling within the category of 'retained waste' subject to comprehensive safeguards;

8. Concurs with the conclusion of the Committee of Inquiry that in future a secure legal basis must be provided for the 'flag swapping' of nuclear materials in order to prevent the circumvention of embargoes and the swapping of materials of dissimilar quality;

9. Calls on the Member States to work to strengthen the powers of the IAEA;

10. Calls on the Member States to work within the IAEA to ensure that future IAEA safeguard implementation reports name countries and installations which have failed to achieve safeguard objectives;

11. Supports the call made by US Secretary of State Schultz for all countries to accede to the Nuclear Non-Proliferation Treaty;

12. Calls on the Euratom Safeguards Directorate to submit a comprehensive annual report to Parliament which would be available to the public;

13. Calls, in addition, for a confidential safeguard implementation report making specific reference to countries and installations to be drawn up for the Euratom Member States;

14. Supports the call made by the Committee of Inquiry for improved parliamentary supervision of Euratom

through the setting up of a special parliamentary supervisory committee whose work would be confidential;

15. In order that Parliament's future committees of inquiry may work effectively, calls for the establishment of normal parliamentary rights — particularly *vis-à-vis* other Community institutions — such as the right to order officials to appear, to take evidence, to inspect official records and lay down means of coercion, instructs its Committee on the Rules of Procedure to draw up corresponding proposals and, in so doing, take account of the experience gathered by the Committee of Inquiry;

16. Instructs its President to forward this resolution to the Commission, the Council, the governments of the Member States and the IAEA.

During the debate both the Commissioner for the Environment and Nuclear Safety, Mr Stanley Clinton Davis and the Commissioner for Energy, Mr Nic Mosar made statements expressing the views of the Commission on certain aspects of the report on the above resolution. The texts of these interventions are reproduced below.

Mr Stanley Clinton Davis

'Mr President,

Members will recall that at the January session of Parliament, the Commission sought permission to interrupt the normal proceedings of the House to make a statement about what had become known as the Transnuklear-Mol affair concerning the transfrontier shipment of radioactive waste. In my own intervention at that time, I disclosed what facts the Commission had already gathered about the affair and reported the concrete measures the Commission had taken in response to those facts. Later, I made a detailed statement to the Committee of Inquiry itself and answered questions over a period of some three hours.

Officials from DG XI also cooperated fully with the Committee of Inquiry as its investigations proceeded. May I remind the House that Commission officials have made five fact-finding visits to the Mol site; three visits to nuclear power stations in the Federal Republic; one visit to a nuclear power station in Italy; one visit to a nuclear power station in Switzerland; one visit to the Nuclear Research Centre at Karlsruhe and numerous visits to government agencies in Belgium and the Federal Republic. The Commission's own enquiries, which had to focus exclusively on those aspects which had a clear Community dimension, have been painstaking and comprehensive. Nobody, I hope, could possibly contest either the Commission's good faith towards the Committee of Inquiry or its commitment to digging out the truth and making the right policy conclusions.

Against this background, the Commission welcomes the conclusions in the Committee of Inquiry's own report, many of which reflect concerns expressed by the Commission in the past. In particular, we agree that Community legislation covering the control of radioactive waste has been shown to be deficient. The inability to track waste throughout its life cycle — a phenomenon I described when I addressed the Committee of Inquiry — has made it impossible, certainly in this case, for the Member States concerned to control the movement of waste. Without an ability to identify waste consignments and to track them through processing, mixing and into storage, it was difficult for the Member States involved in this case to monitor or control the procedures used at Mol or at the temporary storage points in nuclear installations in the Federal Republic. Euratom practices are founded on effective controls being carried out by Member States; given what has come to light in our investigations, the Commission is now acutely aware of the need for Community legislation in the area of waste labelling and tracking in order to standardize best practice. The Commission will, therefore, be coming forward shortly with the necessary proposals and will, in particular, propose that Community provisions of Directive 84/631/EEC on the transfrontier shipment of hazardous waste should be extended so as to apply, in a parallel way, to radioactive waste. If the existing provisions could be amended accordingly, this would impose a regime covering both the control and monitoring of waste and the division of responsibility between transporter and processor — priorities identified in the conclusions of the Committee of Inquiry report.

I also share the Committee of Inquiry's anxieties about the quality of protection that is given to temporary and sub-contract workers in nuclear installations. The Commission has spotlighted this problem in the past and I made a number of references to it in my own submission to the Committee of Inquiry. Plainly, the situation is not satisfactory and I have instructed my officials that, as the Commission's work on revising the Basic Standards Directive proceeds, special attention must be paid, in full consultation with the unions, to the needs of temporary workers. Appropriate proposals — based on Article 31 of Euratom — will, therefore, be forthcoming in the near future. To be worthy of the name, our health and safety protection policies must reach all workers — not just some.

Finally I turn to the question of Community checks of nuclear installations. I have on a number of past occasions stressed the need for more openness in the nuclear industry. Openness, a lack of secrecy, a willingness to be forthcoming in a frank and positive manner builds public confidence and limits the opportunity for bad practice. This was some of the thinking behind the decision to establish the standing conference on nuclear safety and to publish the opinions prepared under Article 37. To carry this further, the Commission is currently re-assessing the procedures for overseeing radioactive waste disposal plans and the potential transfrontier impact of such plans. We believe that these Article 37 procedures should be extended in scope and, on that basis, that opinions given in previous times by the Commission could be usefully reviewed. Secondly, the relevant authorities in the Member States have been informed that the Commission intends to exercise its right of access to monitoring facilities as laid down in Article 35 of Euratom. This is a matter which we have discussed many times in this Chamber and the Commission's attitude will be well known to all who have followed the debates. It must be obvious to all — certainly in the wake of recent events — that exercise of Community powers in this area, so long under-used, would be in the common interest.

Mr President, that the Commission in its inquiry which received the fullest cooperation of the Member States involved, and which extended far beyond the scope of Article 35, has found no evidence of breaches of the basic safety standards in the waste treatment operations at the Mol centre is a source of relief. It is not a source of complacency. Our investigations — as well as those of the national authorities involved — have brought disturbing facts to light. With all that we know of the dangers, it is — certainly from now on — unacceptable for national authorities not to be in a position to know the location, the nature and the source of all radioactive wastes on their territory. Within its competence under the Euratom Treaty, the Commission has a clear duty to propose those measures which the Community has in all logic and common sense now to take following the revelations of policy weakness which the investigations have uncovered. The Commission's agenda is the one which I have summarized for the House today. I can assure the House in conclusion, that that agenda will be promptly and thoroughly addressed.'

Mr Nic Mosar

'Mr President,

May I echo the compliments that my colleague Mr Clinton Davis has just made to the Committee of Inquiry, to its chairman, Mr Sherlock, and to its rapporteur, Mr Schmid.

The report we have here today — after six months of hard work — gives us clear conclusions on Euratom's responsibility in the Transnuklear-Mol affair.

This affair, which triggered this House's inquiry, raised other fundamental issues, over and above the concern with protecting health. Three of them made a great deal of noise politically. Was there any diverting of nuclear substances, particularly to Pakistan and Libya? That was the first question. Were any international commitments violated through the practice of flag swaps? That was the second question. And were any Commission officials corrupted? That was the third.

The Schmid report provides reassuring answers, in all objectivity, to these three questions and they strengthen the credibility of the European Community. I join you in welcoming this — although I should not like to ignore the queries, the many suggestions and the reservations that the report indeed contains and which are reflected in the proposed motions for resolutions. I have looked at them closely and, before letting you know what my reactions to the main ones are, there are one or two remarks I should like to make about various factual aspects of the report.

First of all, the degree of enrichment of the uranium in the 50 drums at Nukem. I can confirm that our inspectors found a figure of 0.66%. These drums are still under Euratom control and stored on the site.

Secondly, the efficiency of the security control. The idea that there is a one in twenty chance of diversion going unnoticed is misleading. This only refers to one of the control procedures — sampling. The other procedures — cameras, seals, experienced inspectors on the spot and so on — should also be taken into account. It is not possible to put a figure on all these measures. But to speak fully and reassuringly on this point, let me say that the difficulties encountered by the IAEA in actually carrying out the monitoring, in five countries particularly, are not in any of the Member States of the Community.

Having said that, I should like to deal with three basic points which were raised in the conclusions to Mr Schmid's report — operation of the safeguards, the rules covering the exchange of obligations and the confidential nature of some of the information.

When it comes to safeguards, I should remind you that Chapter 7 of the Euratom Treaty gives the Community very broad powers. It is an efficient system and fuller than the IAEA one. Those of you who have been to Luxembourg to the seat of the Safeguards Directorate will, I think, have seen this. In view of the recognized performance of our safeguard system, I would very much hesitate to embark upon revision of the Treaty on this point. Instead, I think, with Parliament's help, the Commission can try and exploit the possibilities of the Euratom Treaty even better — and I am in full agreement with the suggestions about increasing both the number of inspections and our body of inspectors. I should add to it our desire to go on improving our technical equipment and the training of the staff responsible for using it. The system already works, but Parliament is right to want to see it improved and the Commission will spare no effort to see this is done.

Mr President, the second basic question raised by the report has to do with the exchange of the obligations relating to nuclear materials. The report of the Committee of Inquiry very rightly points out that, although those swaps are not based on particular legal texts, this does not make them illicit. The practice of swaps developed at the same time as the trade in nuclear materials. So in its internal rules, the Commission brought in rules that are compatible with the international commitments to which the Community subscribes. The effect is to guarantee that the quantity and quality of the substances covered by the most restrictive commitments are not reduced. The Commission has always done and will continue to do its best to adhere to these rules.

Your Committee of Inquiry says it would still be better to legislate in this field — a suggestion which calls for profound reflection by the Commission.

Now as to the particular matter of flag swaps, I should like to repeat that the Commission already made provision to exclude them, in a discussion going outside Community limits, well before the Transnuklear affair.

The third fundamental thing I want to mention is the confidential or secret nature of some of the data gathered by Euratom. The conclusions in the report suggest setting up an advisory committee in Parliament, whose members would be pledged to secrecy. The creation of such an internal committee would not in itself enable the Commission to ignore the obligation to keep confidential certain nuclear data as laid down by the Euratom Treaty and by the legislation adopted pursuant to it. The Commission will continue to cooperate with Parliament, as it has always done, to enable the House to exercise its powers of control as laid down in Article 107 of the Euratom Treaty. So the Commission will continue to supply Parliament with all the information it has and is able to pass on without violating its obligation to keep certain details secret.

Those, Mr President, are the one or two points I wanted to make about the conclusions to the Schmid report. In conclusion, I should say that the six months' work the Committee of Inquiry did were beneficial to both our institutions. Parliament was able to look behind the curtain and get a better grasp of the way the international market in nuclear materials worked and the Commission was able to get a better idea of the nuclear activities which are the cause of greatest concern to the people of Europe and on which it will have to put priority in future. The Commission will not fail to take this into account, of that you can be sure.'

Copies of the report by the Committee of Inquiry (Document A 2-120/88/PARTA) are available on request.

Short-term outlook in the European Community[1]

Introduction

The last issue of Energy in Europe *(No 11) forecast a growth of global energy demand for 1988 in the order of 1.4%. It is now becoming clear, after data for the first half of the year has become available, that the exceptional weather conditions during the first months of 1988 had a very important impact on demand, estimated at about 1.5%. For this reason and despite a combination of high economic growth and falling oil prices, global energy demand in 1988 could finally increase by only 0.2%.*
However, if we assume a return to 'normal' weather conditions during 1989, and on the basis of an assumption of continuing economic growth (2.8%) and low oil prices (USD 14.5/b as compared to an average of USD 14.7/b in 1988), global energy consumption in 1989 could grow by more than 3%.
According to our latest forecast oil deliveries could grow by more than 2%, due mainly to demand in the transportation sector.
Demand for natural gas, which was down by 4% in 1988, could regain its high levels of 1987.
Solid fuels could remain at the same levels as in 1988, mainly because of demand by the power sector.
Finally electricity demand is likely to increase substantially, by almost 4%, with nuclear production growing even faster (6.5%).
A summary of the main assumptions used in the preparation of this forecast and the main results are shown in Table 1.

Table 1: EUR 12
Summary of main assumptions and results
(Last revision: 17 November 1988)

	1985	1986	1987	*1988*	*1989*	Annual percentage change 1985	1986	1987	*1988*	*1989*
I. Main assumptions										
GDP (1980=100)	107.0	109.7	112.7	*116.7*	*119.9*	2.4	2.5	2.8	*3.5*	*2.8*
Private consumption (1980=100)	107.5	111.7	115.9	*120.2*	*123.8*	2.6	4.0	3.7	*3.7*	*3.0*
Industrial production (1980=100)	103.4	105.5	107.8	*111.5*	*115.0*	3.4	2.1	2.2	*3.5*	*3.1*
Consumer prices (1980=100)	153.6	159.1	163.7	*168.9*	*175.1*	6.1	3.6	2.8	*3.2*	*3.7*
Imported crude oil price (USD/b)	27.54	14.51	17.93	*14.66*	*14.50*	—5.0	—47.3	23.6	*—18.2*	*—1.1*
(ECU/b)	36.40	14.91	15.55	*12.50*	*12.61*	—1.0	—59.0	4.2	*—19.6*	*0.9*
II. Main results										
Oil Total inland deliveries (Mt)	429.2	441.1	442.1	*446.6*	*455.8*	—3.7	2.8	0.2	*1.0*	*2.1*
Hard coal Total inland deliveries (Mt)	327.5	327.3	318.9	*313.7*	*315.0*	21.0	—0.1	—2.5	*—1.6*	*0.4*
Natural gas Gross consumption (Mtoe)	184.5	186.8	198.9	*192.0*	*199.7*	4.7	1.3	6.5	*—3.5*	*4.0*
Electricity Consumpt. intern. market (Twh)	1 377.9	1 415.7	1 462.6	*1 497.6*	*1 554.0*	4.0	2.7	3.3	*2.4*	*3.8*
Nuclear heat Production (Twh)	1 440.3	1 537.5	1 580.4	*1 656.4*	*1 763.9*	29.6	6.8	2.8	*4.8*	*6.5*
Total energy Gross inl. consumption (Mtoe)	1 029.4	1 043.8	1 061.3	*1 063.8*	*1 097.4*	3.9	1.4	1.7	*0.2*	*3.2*
Energy ratio Total gr. inl. consumption/ GDP (1984=100)	101.5	100.3	99.3	*96.2*	*96.5*	1.5	—1.1	—1.0	*—3.1*	*0.4*

[1] Manuscript completed on 30 November 1988.

Energy in 1988

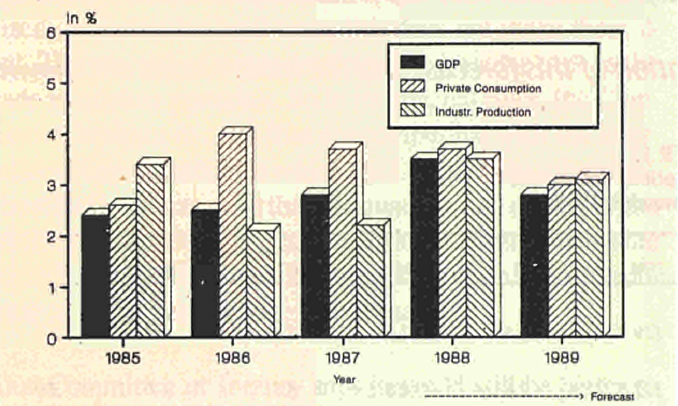
At the time of preparation of this report, statistical information for 1988 was still incomplete and covered only the first half of 1988. In other words the figures for 1988 are forecasts.

Nevertheless, available information shows that 1988 was, from different points of view, an atypical year for energy consumption.

Three conflicting factors were in play during the year:

(i) An unexpectedly high growth in economic activity. The latest estimation of DG II (October 1988) for GDP growth in EUR 12 for 1988, is 3.5% (Graph 1).

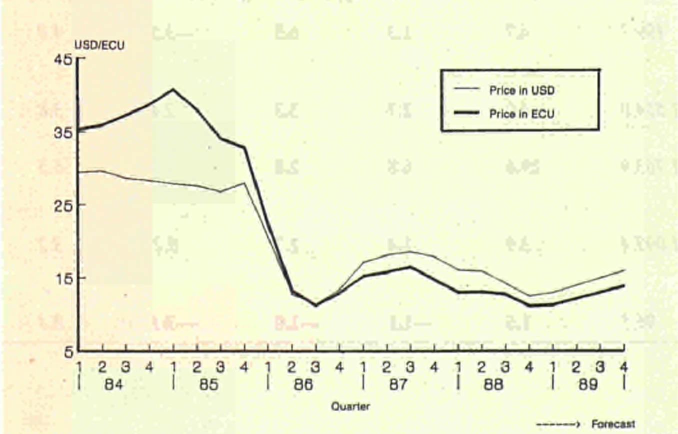
Graph 1 - EUR 12: Macroeconomic indicators
Annual percentage change



(ii) Exceptional weather conditions during the first half of the year. The number of degree-days was 13% less than 'normal' and 20% less than in 1987. We estimated the global impact of these climatic conditions to be about 16 million toe (Box A).

(iii) The crude oil price, which was around USD 16/b during the first half of the year collapsed during the second half, reaching USD 11/b at the beginning of October.

Graph 2 - EUR 12: Average crude oil import price/barrel



Our estimate for the average import price during the fourth quarter of 1988, made before the end-November meeting of OPEC, is of USD 12.5/b. The average for the year is, therefore, of USD 14.7/b, about 18% less than in 1987 (Graph 2).

Given the weather impact, global energy consumption during the first half of the year declined by 1.8% compared to the first half of 1987.

Box A

An estimation of the weather effects on 1988 energy demand

The exceptionally good weather during the first half of 1988 had a strong effect on energy demand. Using our STEM model we tried to isolate the weather effect from all the other factors determining demand. To do this, a simulation was made under the assumption that 1988 had had identical weather conditions to those in 1987.

The results are summarized in the following table:

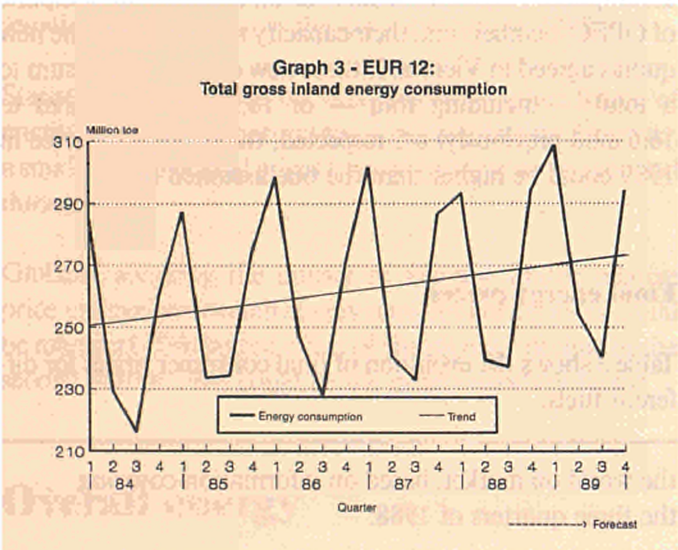
Table A
Analysis of weather effects on 1988 energy demand

	1987 observed	1988 forecast	Weather effect	Weather % of 1988	1988 Adjusted
Deliveries hard coal (Mt)					
Domestic	16.0	14.7	0.3	2.4	15.0
Power generation	194.9	194.2	4.7	2.4	198.9
Total	318.9	313.7	5.1	1.6	318.8
Deliveries oil (Mt)					
Heating gasoil	98.4	94.3	2.2	2.3	96.4
Heavy fuel oil	70.5	66.3	0.9	1.4	67.2
Motor spirit	97.9	101.4	—0.8	—0.8	100.6
Total	442.1	446.6	2.3	0.5	448.9
Natural gas (Mtoe)					
Final consumption	167.0	160.4	8.2	5.1	168.6
Electricity (TWh)					
Final consumption	1 391.7	1 425.1	18.9	1.3	1 444.0
Gross generation	1 658.5	1 689.7	21.2	1.3	1 710.9
Gross inland consumption (Mtoe)					
Solids	232.6	230.5	4.1	1.8	234.6
Oil	473.4	476.9	2.5	0.5	479.4
Natural gas	198.9	192.0	9.1	4.7	201.1
Others	156.4	164.4	0.2	0.1	164.6
Total	1 061.3	1 063.8	15.9	1.5	1 079.7

Source: STEM model.

As can be seen from this table, the global weather effect can be estimated to be about 16 mtoe, which is the equivalent of 1.5% of total inland consumption. In other words, under similar weather conditions as in 1987, the growth of global energy demand in 1988 could have been in the order of 1.7%, with electricity demand being close to 4%. Natural gas was the fuel most affected by the weather.

However, under the combined effect of faster economic growth and falling prices, global energy demand could grow by 1.9% during the third quarter and by 2.7% during the fourth quarter, leading to an overall annual growth of about 0.2% (Tables 4, 8 and 9, graph 3).



It is not impossible that this underestimates the impact of fast economic growth during the later months of 1988. If this is the case, overall energy demand could turn out to be slightly higher, approaching 0.5%. Box B recalls the evolution of the outlook' for 1988, showing clearly the role played by unexpected changes in exogenous assumptions related to economic activity and weather.

Working assumptions for 1989

The main working assumptions underlying the 1989 forecasts are presented in Table 2.

As usual these working assumptions for macroeconomic variables are based on the most recent economic forecasts published by DG II (October 1988). These assume, for 1989, an average GDP growth rate for EUR 12 of 2.8% (against 2.3% forecasted in June and 1.8% in January). This is somewhat less than the 3.5% growth of 1988 but it is still relatively high.

Internal demand will probably continue to grow faster than GDP. An assumption of a 3% growth in private consumption is made.

Inflation could be a little stronger than in 1988, but still less than 4%.

Box B

Short-term forecasting is not easy: history of our 1988 forecasts

As is observed in the main text, it appears that 1988 has been an unusual year for several reasons: unexpected growth, in spite of the stock market crash of October 1987; falling oil prices, exceptional weather conditions.

Forecasting under these conditions is very difficult. The following table, shows the evolution of our forecasts for 1988 over the last year:

Evolution of forecasts for 1988

EE Issue		(1)	(2)	(3)	(4)	(5)	(6)	(7)
No 8	10/87	EUR 10	1q87	0.4	2.3	18.0	0.0	0.0
No 9	12/87	EUR 12	2q87	0.6	1.5	19.2	0.3	0.0
No 10	4/88	EUR 12	3q87	0.8	1.9	16.0	0.5	0.0
No 11	9/88	EUR 12	4q87	1.2	2.6	16.0	1.4	—0.5
No 12	12/88	EUR 12	2q88	1.7	3.5	14.7	0.2	—1.5

[1] Coverage
[2] Latest known quarter
[3] 1987-Gross inland consumption — Growth rate in %.
[4] 1988-GDP growth in %.
[5] 1988-Oil price, USD/b.
[6] 1988-Gross inland consumption (GIC) — Growth rate in %.
[7] 1988-Estimated weather effect — in % of GIC.

The earlier forecasts (Nos 8 to 10), which assumed 'normal' weather conditions, lower GDP growth and higher prices, gave low results for both 1987 and 1988. In our most recent issue (No 11-9/88), in comparison with what happened in 1988, we underestimated the effects of weather and overestimated the effects of economic activity, probably under the influence of the sudden growth of demand during the fourth quarter of 1987.

It is worth noting that data revisions can be very important and, sometimes, can change our perception of the recent past.

The average price of imported crude oil is assumed to stay at approximately the same levels as in 1988 (see next section).

It was assumed that 'normal' weather conditions would be experienced for the last quarter of 1988 and for 1989. This means that the first half of 1989 would be much colder than the same period of 1988.

Energy prices

The oil price

The price of crude oil declined steadily from USD 19/b in August 1987, with only some short-term variations during the spring of 1988, until October 1988, when it reached USD 11/b before returning to about USD 13/b just before the OPEC meeting in Vienna at end-November (Graph 2).

This fall of oil prices is easily explained by OPEC overproduction. As is shown in Box C, the average production of crude oil by OPEC during 1988 was in the range of 19 to 19.5 mbd, compared to 17.7 mbd in 1987.

Our forecast for 1989, made before the OPEC agreement in Vienna, assumes a slow but steady return to higher prices by the end of 1989. This hypothesis gives an average price of USD 16/b by the fourth quarter of 1989 and an average price of USD 14.5/b for the year.

This is, of course, not a forecast but a plausible working assumption. A great deal depends on the internal discipline of OPEC members and their capacity to conform to the new quotas agreed in Vienna. If these new quotas, which sum to a total — including Iraq — of 18.5 mbd (compared to 16.6 mbd previously) are respected, the average oil price in 1989 could be higher than the one assumed here.

Final energy prices

Table 3 shows the evolution of final consumer prices for different fuels.

Box C

The world oil situation

In the short-term outlook published in issue No 9 (December 1987, Box C: 'The price of oil: will 1988 be a repeat of 1986?'), we presented two alternative scenarios for the world oil market in 1988, leading to two different average prices: USD 19.2/b and USD 14.2/b. We know by now that the second scenario was much closer to reality.

This scenario assumed for 1988 an increase of world supply (over 1987) of 1.3 mbd, coming mainly from the OPEC countries.

The following table presents the recent situation on the world oil market, based on information covering the three quarters of 1988:

OPEC production during the first three quarters of 1988 was, on average, 1.3 mbd higher than in 1987 and total supply was about 1.9 mbd higher. Available information for October and November 1988 shows another important increase in OPEC production (to more than 21 mbd of crude). By the end of the year, average 1988 OPEC production could be 1.5 mbd higher than in 1987.

In other words, expanded supply by OPEC, but also by some non-OPEC producers, can explain the drop in crude oil prices during 1988.

World oil demand and supply (mbd) excluding CPEs	1986	1q87	2q87	3q87	4q87	1987	1q88	2q88	3q88	4q88[1]	1988	87/86-%	88/87-%	88/87-mbd
Demand														
1. OECD	35.2	36.5	34.3	35.5	36.9	35.8	37.4	35.0	35.9	37.8	36.5	1.7	2.0	0.7
2. LDCs	12.7	13.0	12.5	13.0	13.4	13.0	13.3	12.8	13.3	13.7	13.3	2.2	2.3	0.3
Total demand	47.9	49.5	46.8	48.5	50.3	48.8	50.7	47.8	49.2	51.5	49.8	1.8	2.1	1.0
Supply														
1. Non-OPEC	28.3	28.4	28.5	29.0	29.4	28.8	29.2	29.3	29.3	29.5	29.3	1.9	1.7	0.5
2. OPEC NGL	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7			0.0
Call on OPEC crude	18.0	19.4	16.6	17.8	19.2	18.3	19.8	16.8	18.2	20.3	18.8	1.4	2.9	0.5
3. OPEC crude	17.9	15.6	16.9	19.2	18.9	17.7	17.5	18.6	19.6	21.0	19.2	—1.4	8.6	1.5
Total supply	47.8	45.7	47.1	49.9	50.0	48.2	48.4	49.6	50.6	52.2	50.2	0.8	4.2	2.0
Stocks etc.	—0.1	—3.8	0.3	1.4	—0.3	—0.6	—2.3	1.8	1.4	0.7	0.4			1.0

[1] Forecasts made before end-November OPEC meeting.
Sources: IEA, OPEC, DG XVII.

Average final prices of oil products remained almost stable during 1988. One exception was the price of residual fuel oil which followed the drop in the price of crude oil.

Following on from the assumption concerning the price of crude oil, average final prices of oil products in 1989 could remain at approximately the same levels as in 1988.

Statistical information on final prices of other forms of energy, in particular natural gas, is not satisfactory. However, a small decline of final prices for coal and gas can be expected during 1989.

Globally speaking the impact of absolute and/or relative price changes on overall energy demand during 1989 could be marginal. The lagged effect of the oil price decline in the second half of 1988 could be the more important factor.

Overall energy

Under our macroeconomic and price assumptions and based on the technical hypothesis of a return to 'normal' weather conditions, global energy demand in 1989 could, for the first time since 1985, grow by more than 3% (Tables 4, 8 and 9, Graph 3).

The combined effects of economic activity in both 1988 and 1989 is the main factor contributing to this forecast. Nevertheless, the assumption of 'normal' weather in 1989 explains about 1% of additional demand. Box D presents the relative role of different 'sources' of energy consumption growth for 1989.

After an important slowdown during 1987 and 1988, nuclear will be probably the fastest growing energy sector (6.5%). At the same time, consumption of natural gas, which was the fuel most affected by weather conditions in 1988, could also grow rapidly (around 4%).

Faster economic growth and lower prices could lead to a high oil demand, with an increase in the range of 2.1% (in total inland deliveries).

Finally an important increase in electricity demand (3.8%) could be beneficial to the solid fuels.

Under these conditions, the global energy ratio, defined as the ratio between total primary energy consumption and GDP, could for the first time since 1985 increase slightly. However, the average growth of primary energy consumption for 1988 and 1989 should not exceed 1.7%. This will be significantly lower than the average GDP growth of 3.1% for the same period. In other words, even with low prices, there is a further improvement in energy intensity.

Box D

The sources of growth of global energy demand in 1989

Our forecast for total energy consumption in 1989 shows a growth rate of 3.2%, significantly higher than the one observed during the period 1986-88.

As explained in the main text, this forecast is based on three facts and/or working assumptions:

(a) Return to 'normal' weather conditions.

(b) Low levels of energy prices.

(c) High growth of economic activity during both 1988 (+3.5%) and 1989 (+2.8%).

The following table tries to disaggregate the effects of these three factors on the overall growth of gross inland energy consumption for 1989.

EUR 12, 1989: Growth rate of gross inland consumption by sources, in %

	Total	Weather	Prices	Others Total	of which: Economic 1989	activity Older	Structural factors
Solids	1.4	1.2	—0.5	0.7	1.3	3.3	—3.9
Oil	2.7	0.3	0.3	2.1	2.6	3.8	—4.3
Natural gas	4.0	2.7	0.5	0.8	0.7	1.9	—1.8
Others	6.0	0.1	0.1	5.8	0.3	0.2	5.3
Total	3.2	0.9	0.1	2.1	1.6	2.8	—2.3
for memory: Total-Mtoe	33.6	9.5	1.4	22.7	17.1	30.1	—24.5

Source: STEM model.

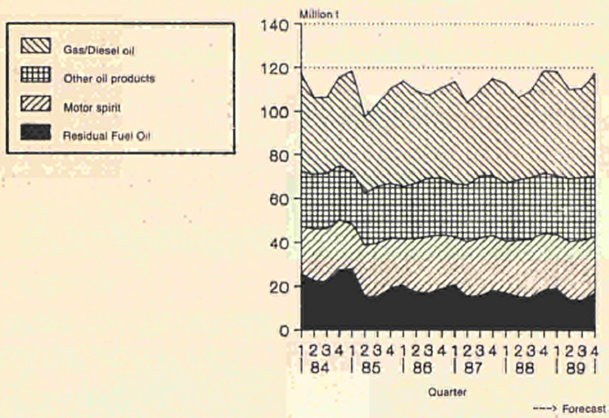
This kind of analysis, made by econometric methods, must be used with caution, and especially the disaggregation between short-term and long-term effects of economic activity and the residual 'structural' factors.

However, it has the merit of showing the important effect of weather conditions (almost 1% of additional demand), the shift between fuels due to relative prices and the important role of economic activity during 1988 and 1989.

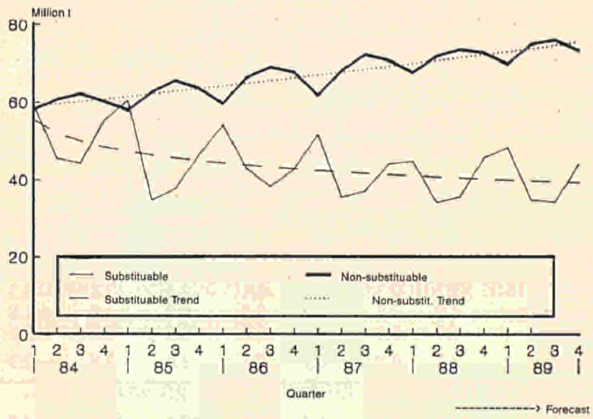
Oil

During the last years the split of the oil products market into two separate parts with different behaviour is becoming clearer. On the one hand, the substitutable part (heating gasoil and heavy fuel oil) is declining steadily, while on the other hand the non-substitutable part (transportation fuels and products for non-energy uses) continues to grow (Table 5, Graphs 5 and 6).

Graph 5 - EUR 12:
Total inland oil deliveries



Graph 6 - EUR 12:
Inland deliveries of oil products



This dissimilarity in behaviour probably continued during 1988. The climatic conditions affected deliveries of heating gasoil which were 9.5% lower in the first semester of 1988, compared to 1987. We estimate that by the end of the year, total inland deliveries of substitutable fuels could be 5% less than in 1987.

At the same time, demand for transportation fuels and in particular automotive diesel oil continued to grow very rapidly. Inland deliveries of diesel oil in 1988 could be more than 50% higher than in 1984. This corresponds to an average annual growth rate of more than 10% over the last four years!

Our forecast for 1989 expects a slight change in this situation. Given the fact that, by the end of summer 1988, consumer stocks of heating oil were probably at the same level as in 1987 and much less than in 1986, it is possible that consumers will decide to increase their stocks in the first half of 1989. This would depend on their expectations concerning price evolution. At the same time, a return to 'normal' weather conditions could increase demand substantially. Under these assumptions deliveries of heating gasoil could increase in 1989 by 2% to 3%.

Heavy fuel oil will probably continue to lose its market share in industry but it could benefit from increased demand by the power sector. Deliveries could be in the range of 2% to 3% less than in previous years.

Demand for transportation fuels will probably continue to grow but perhaps less quickly than in the past due to price stabilization and a slightly smaller growth in private income.

Overall, global deliveries of oil products could grow, in 1989, by more than 2%:

Inland deliveries — Annual growth rate, in %

	1984/87	1988[1]	1989[1]
Substitutable fuels	—6.2	—4.9	0.5
Non-substitutable fuels	4.3	4.7	2.9
of which: Transportation fuels	5.7	5.3	3.4
Total	—0.2	1.0	2.1

[1] Forecasts.
Source: Appendix, Table 5.

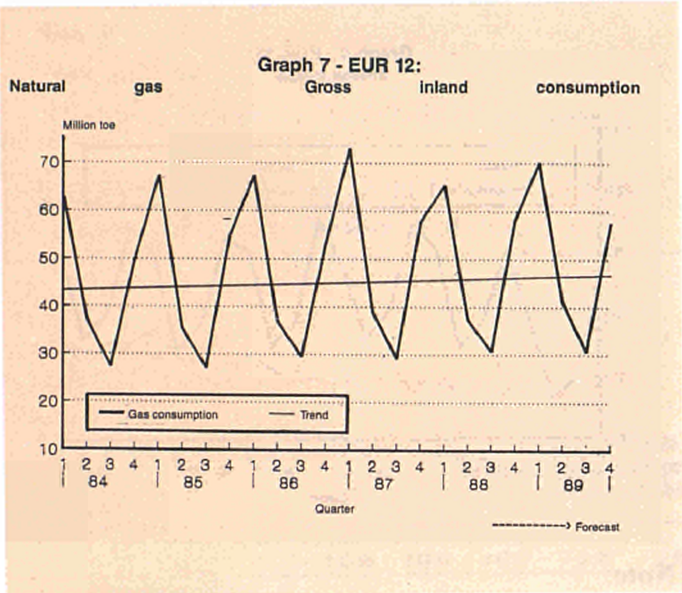
On the supply side, production in 1988 has been affected by the accident and loss of Piper Alpha and linked fields (at least 3 million tonnes). In 1989 total production could be a little higher than in 1988 but still less than in 1987. Net imports could, therefore, increase by 8 million tonnes.

Natural gas

Demand for natural gas was strongly affected by the weather during 1988. After an increase of 6.5% in 1987, final demand probably decreased by 4% in 1988 (Table 5, Graph 7).

Given the assumption of 'normal' climatic conditons, final consumption in 1989 may grow by more than 3.5% reaching almost the same level as in 1987. The usual lagged effect of falling oil prices on gas prices, already observed in 1987, could drive demand even higher.

Total gross inland consumption of natural gas, including transformation in power stations, could grow by 4% during 1989 approaching for the first the 200 mtoe 'barrier'.

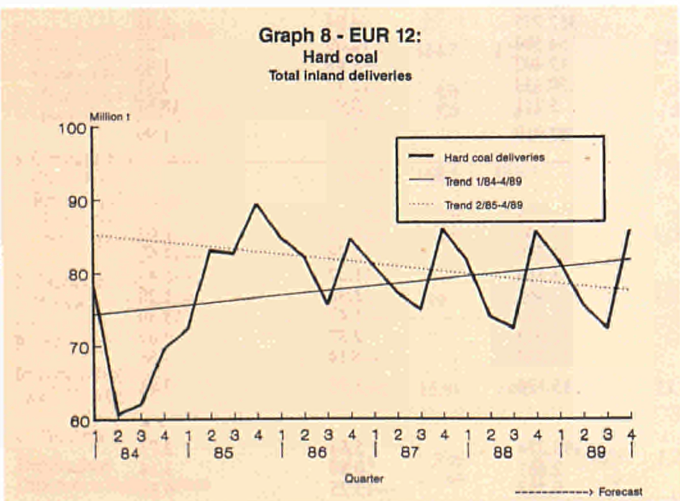


Graph 7 - EUR 12: Natural gas Gross inland consumption

Solid fuels

During 1988 total gross inland consumption of solid fuels could diminish by about 1%, compared with a small growth of 0.5% in 1987 (Table 6).

Despite a more or less constant level of deliveries to power stations, total inland deliveries of hard coal could diminish by 5 million tonnes during 1988, mainly because of the coking and domestic sectors (Graph 8).



Graph 8 - EUR 12: Hard coal Total inland deliveries

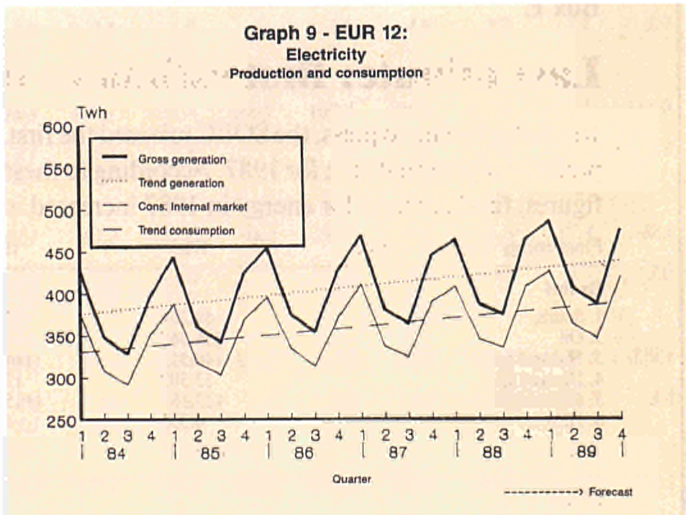
Given our forecast for electricity (see below) a slight increase in deliveries to power stations in 1989 could bring a stabilization or even a slight increase in total deliveries of hard coal. However, the needs of the power sector could lead, for the third consecutive year, to a decrease in stocks.

Provisional estimates for 1988 show a decrease in hard coal production of about 8 million tonnes. At the same time, it seems that there has been a significant increase in net imports. According to recent forecasts by Member States, production could decrease in 1989 by another 3 to 4 million tonnes. Under these conditions, net imports in 1989 could be greater than 100 million tonnes.

Quarterly data on lignite are, unfortunately, not very reliable. Nevertheless, it seems that after stagnation in 1988, consumption in power stations could increase significantly in 1989 (by about 5%).

Electricity

Electricity demand during the first half of 1988 was also affected by the weather. However, given the growth of economic activity, final demand by the end of the year could be by 2.4% higher than in 1987 (Table 7, Graph 9).



Graph 9 - EUR 12: Electricity Production and consumption

During the last three years (1985, 1986 and 1987) average growth of electricity consumption (variable: electricity 'available for the internal market') was 3.4% against 2.6% for GDP growth. Including forecasts for 1988 the figures become 3.2% and 2.8% respectively. In other words, electricity demand is growing faster than GDP and electricity intensity is rising.

It now seems likely that this situation will continue during 1989. Based on our assumptions, electricity demand could grow by almost 4% in 1989.

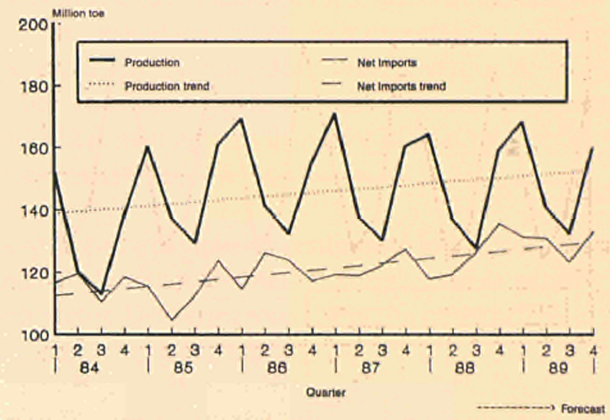
The biggest part of this increased demand would probably be satisfied by the nuclear sector. Production of nuclear heat could increase by 6.5%.

However, production of electricity by conventional thermal power stations could also rise by almost 3%, which means some 6 Mtoe of additional inputs to conventional power stations. All sources of energy (solids, oil products and gas) will probably increase their contribution to the power sector.

Imports

On the basis of this outlook, total net imports of energy could increase by 19 million toe (Table 4, Graph 4). Net imports in 1989 are forecast to represent about 46% of total primary energy consumption, as compared to 43.4% in 1985, 44.8% in 1987 (latest observed figure) and 45.6% in 1988 (Table 4). In other words, it appears that since 1986 net imports are following an upward trend, although net oil imports could make up a smaller part of total energy consumption than in 1986.

Graph 4 - EUR 12: Energy supply



Note:
This report is based on statistical data available at 4 November 1988 and covering, generally, the first two quarters of 1988.

Box E

Last minute: first estimates on 1987 final energy demand

Just before going to press, the SOEC released the first, preliminary, annual data for 1987. According to these figures, final demand for energy in 1987 increased in EUR 12 by 2%, with natural gas growing by more than 7% and electricity by almost 4%.

Final energy demand — Mtoe	1985	1986	1987	1986/85	1987/86
By fuel					
1. Solids	68.260	62.180	58.191	−8.91	−6.42
2. Oil	336.962	350.582	352.275	4.04	0.48
3. Natural gas	140.513	144.030	154.507	2.50	7.27
4. Derived gas	13.502	12.227	12.402	−9.44	1.43
5. Electricity	112.685	115.810	120.333	2.77	3.91
6. Heat	4.355	4.395	5.211	0.92	18.57
Total	676.277	689.224	702.919	1.91	1.99
By use					
1. Industry					
Hard coal	18.194	16.675	17.345	−8.35	4.02
Coke	27.344	24.393	21.559	−10.79	−11.62
Other solids	2.229	1.971	1.864	−11.57	−5.43
Oil	50.381	52.086	51.460	3.38	1.20
Natural gas	51.089	50.340	57.033	−1.47	13.30
Electricity	49.507	50.682	52.033	2.37	2.67
Other	14.262	13.101	13.830	−8.14	5.56
Total	213.006	209.248	215.124	−1.76	2.81
2. Transport					
Oil	178.234	188.281	195.374	5.64	3.77
Electricity	2.752	2.774	2.861	0.80	3.14
Other	0.415	0.360	0.383	−13.25	6.39
Total	181.401	191.415	198.618	5.52	3.76
3. Domestic					
Hard coal	12.687	12.391	10.927	−2.33	−11.82
Other solids	7.631	6.571	6.354	−13.89	−3.30
Oil	108.347	110.215	105.441	1.72	−4.33
Natural gas	89.204	93.447	97.232	4.78	4.05
Electricity	60.426	62.354	65.439	3.19	4.95
Other	3.595	3.583	3.784	−0.33	5.61
Total	281.870	288.561	289.177	2.37	0.21
Total final consumption	676.277	689.224	702.919	1.91	1.99

Source: SOEC, 25 November 1988.

Box F

Now available!

Short-term outlook on PC diskette

DG XVII is now offering all the historical data and forecasts published in the short-term outlook on PC floppy disk. You can now consult these data on your personal computer.

For more information, please contact the Editor.

Table 2 - EUR 12
Macroeconomic, oil price, and weather assumptions
(Data available 4 November 1988)

									Year					
	1 Q 88	2 Q 88	3 Q 88	4 Q 88	1 Q 89	2 Q 89	3 Q 89	4 Q 89	1984	1985	1986	1987	1988	1989
A. Macroeconomic variables														
1. Gross domestic product (GDP) (1980=100)	115.3	115.6	116.9	118.9	119.4	119.8	120.1	120.4	104.5	107.0	109.7	112.7	116.7	119.9
Percentage change														
from prior year	3.6	3.1	3.0	4.3	3.6	3.6	2.7	1.3		2.4	2.5	2.8	3.5	2.8
from prior quarter (x4)	4.5	1.2	4.5	6.8	1.8	1.2	1.0	1.2						
2. Private consumption (1980=100)	118.8	119.0	120.6	122.2	123.0	123.5	124.0	124.5	104.7	107.5	111.7	115.9	120.2	123.8
Percentage change														
from prior year	4.4	3.1	3.4	3.8	3.5	3.8	2.8	1.9		2.6	4.0	3.7	3.7	3.0
from prior quarter (x4)	3.7	0.7	5.4	5.2	2.5	1.9	1.5	1.6						
3. Industrial production (1980=100)	114.0	113.3	101.0	117.8	117.9	116.8	104.1	121.1	100.0	103.4	105.5	107.8	111.5	115.0
Percentage change														
from prior year	3.9	3.2	3.5	3.4	3.4	3.1	3.1	2.8		3.4	2.1	2.2	3.5	3.1
from prior quarter (x4)	0.4	—2.5	—43.4	66.4	0.4	—3.6	—43.4	65.0						
4. Iron and steel industry (1980=100)	99.3	101.1	90.5	98.8	102.3	104.1	93.2	101.8	94.2	96.7	91.6	91.3	97.4	100.3
Percentage change														
from prior year	9.0	4.5	8.7	5.0	3.0	3.0	3.0	3.0		2.6	—5.2	—0.3	6.7	3.0
from prior quarter (x4)	22.1	7.0	—42.0	37.0	14.1	7.0	—42.0	37.0						
5. Chemical industry, SA (1980=100)	122.7	124.3	126.3	127.7	128.9	129.3	129.4	130.0	111.3	115.2	116.1	120.2	125.2	129.4
Percentage change														
from prior year	5.0	4.0	4.0	4.0	5.0	4.0	2.5	1.8		3.5	0.7	3.5	4.2	3.3
from prior quarter (x4)	—0.2	5.0	6.4	4.6	3.7	1.1	0.5	1.8						
6. Consumer price index (1980=100)	166.1	168.1	169.7	171.7	173.1	174.5	175.8	177.2	144.8	153.6	159.1	163.7	168.9	175.1
Percentage change														
from prior year	2.5	2.9	3.5	4.0	4.2	3.8	3.6	3.2		6.1	3.6	2.8	3.2	3.7
from prior quarter (x4)	2.4	4.8	3.8	4.7	3.2	3.3	3.0	3.2						
7. Exchange rate (1 ECU = xx US/$)	1.233	1.216	1.114	1.120	1.150	1.150	1.150	1.150	0.790	0.762	0.983	1.154	1.171	1.150
B. Oil price														
Imported crude oil (caf, US$/barrel)	16.02	15.91	14.20	12.50	13.00	14.00	15.00	16.00	28.98	27.54	14.51	17.93	14.66	14.50
C. Weather														
Degree days	1 134	336	0	1 012	1 256	431	0	1 012	2 748	2 806	2 711	2 776	2 482	2 699
Difference from average	—122	— 95	0	0	0	0	0	0	49	107	12	77	—217	0

Source: Eurostat, DG XVII.

Table 3 - EUR 12
Energy prices
(Last revision: 17 November 1988)

	1 Q 88	2 Q 88	3 Q 88	4 Q 88	1 Q 89	2 Q 89	3 Q 89	4 Q 89	Year 1984	1985	1986	1987	1988	1989
1. Imported crude oil (cif)														
USD/barrel	16.02	15.91	14.20	12.50	13.00	14.00	15.00	16.00	28.98	27.54	14.51	17.93	14.66	14.50
ECU/barrel	12.99	13.08	12.75	11.16	11.30	12.17	13.04	13.91	36.77	36.40	14.91	15.55	12.50	12.61
Growth rate from previous quarter, in %														
USD/barrel	— 10.4	— 0.7	— 10.7	—12.0	4.0	7.7	7.1	6.7		— 5.0	— 47.3	23.6	—18.2	—1.1
ECU/barrel	— 11.8	0.7	— 2.6	—12.4	1.3	7.7	7.1	6.7		— 1.0	— 59.0	4.2	—19.6	0.9
Real prices in ECU														
(in 1980 prices)	7.8	7.8	7.5	6.5	6.5	7.0	7.4	7.9	25.4	23.7	9.4	9.5	7.4	7.2
(in 1986 prices)	12.4	12.4	12.0	10.3	10.4	11.1	11.8	12.5	40.4	37.8	14.9	15.1	11.8	11.4
Growth rate from previous quarter, in % (in real ECU)	—12.3	—0.5	—3.5	—13.5	0.5	6.8	6.3	5.8		— 6.5	—60.4	1.2	—22.1	—2.8
2. Imported naturalgas (cif)														
USD/toe	100.49	99.41							149.4	153.0	143.5	99.7		
Growth rate from previous quarter, in %	— 3.3	— 1.1								2.4	— 6.2	—30.5		
3. Imported steam coal														
USD/tce	43.83	45.90	45.60	45.56	45.06	44.46	43.86	43.53	50.98	51.60	48.30	43.07	45.22	44.23
ECU/tce	35.55	37.75	40.93	40.68	39.18	38.66	38.14	37.85	64.70	68.15	49.30	37.35	38.73	38.46
4. Oil products - Final consumer prices														
Gasoline (ECU/1000 lt)	601.6	620.3	627.2	625.0	616.8	623.9	629.5	634.6	722.2	752.4	624.5	617.5	618.5	626.2
Diesel (ECU/1000 lt)	380.8	382.3	395.3	394.7	397.5	404.6	413.0	421.9	481.4	506.1	396.8	386.3	388.3	409.3
Heating oil (ECU/1000 lt)	229.0	230.7	234.7	229.4	228.3	231.6	236.2	241.2	370.3	395.8	258.0	245.4	231.0	234.3
Residual Fuel Oil (ECU/t)	91.6	96.4	97.9	87.9	86.4	89.6	93.8	98.0	242.4	243.4	122.1	116.3	93.5	91.9
Growth rate from previous quarter, in %														
Gasoline	—2.1	3.1	1.1	—0.4	—1.3	1.1	0.9	0.8		4.2	—17.0	—1.1	0.2	1.2
Diesel	—1.8	0.4	3.4	—0.1	0.7	1.8	2.1	2.2		5.1	—21.6	—2.6	0.5	5.4
Heating oil	—6.8	0.7	1.7	—2.3	—0.5	1.4	2.0	2.1		6.9	—34.8	—4.9	—5.9	1.5
Residual fuel oil	—18.6	5.3	1.5	—10.2	—1.8	3.8	4.7	4.5		0.4	—49.8	—4.7	—19.7	—1.6
5. Natural gas — Final consumer prices														
Households (1984=100)	82.7	82.9	84.5	78.6	79.2	81.5	83.2	77.9	100.0	104.9	97.8	83.1	82.2	80.5
Industry (1984=100)	63.5	62.6	61.1	59.8	58.0	56.7	56.3	56.6	100.0	108.5	89.6	65.9	61.8	56.9
Growth rate from previous quarter, in %														
Households	1.8	0.2	2.0	—7.0	0.8	2.9	2.1	—6.3		4.9	—6.7	—15.0	—1.2	—2.1
Industry	—3.8	—1.3	—2.4	—2.1	—3.1	—2.2	—0.7	0.4		8.5	—17.5	—26.5	—6.2	—7.9
6. Coal — Final consumer prices														
Households (ECU/t)	198.7	194.5	189.6	191.4	193.4	188.9	184.6	186.2	193.8	203.6	199.1	194.5	193.6	188.3
Industry	90.4	89.7	89.7	89.6	89.3	88.2	88.9	89.3	94.1	96.6	92.7	89.7	89.9	88.9
Growth rate from previous quarter, in %														
Households	1.3	—2.1	—2.5	1.0	1.0	—2.3	—2.3	0.9		5.1	—2.2	—2.3	—0.5	—2.7
Industry	1.1	—0.7	0.0	—0.1	—0.3	—1.3	0.8	0.5		2.7	—4.1	—3.2	0.2	—1.0

Sources: IEA; DG XVII estimates.

Table 4 - EUR 12
Primary energy balance (million toe)
(Last revision: 17 November 1988)

	1 Q 88	2 Q 88	3 Q 88	4 Q 88	1 Q 89	2 Q 89	3 Q 89	4 Q 89	Year 1984	1985	1986	1987	1988	1989
Primary production														
Solid fuels:	42.0	39.5	38.5	43.3	41.8	39.5	38.1	43.0	145.0	169.7	174.0	167.9	163.2	162.5
Hard coal	34.0	32.4	30.6	34.4	33.5	31.9	30.2	33.8	107.4	133.8	140.1	136.2	131.4	129.3
Lignite	8.0	7.1	7.8	8.9	8.4	7.7	8.0	9.2	37.6	35.9	33.9	31.7	31.8	33.3
Oil	38.2	35.8	33.7	36.6	37.0	35.2	37.3	37.8	145.5	149.2	150.1	148.0	144.3	147.2
Natural gas	40.1	23.1	18.7	36.0	43.4	24.5	17.7	34.2	119.4	126.7	123.6	128.5	117.9	119.8
Heat	38.9	33.2	32.9	39.9	41.8	36.2	35.1	41.1	97.8	126.0	134.4	138.3	144.9	154.2
Primary electricity	4.6	4.9	3.3	2.7	3.8	4.9	3.7	3.1	14.8	14.4	14.0	14.9	15.5	15.5
Other	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.5	1.6	1.7	1.7	1.7	1.8	1.9
Total	164.2	137.0	127.5	158.9	168.3	140.8	132.3	159.7	524.0	587.5	597.8	599.1	587.6	601.1
Recovered production														
Hard coal	0.6	0.5	0.6	0.7	0.6	0.6	0.6	0.6	2.4	3.3	3.1	2.3	2.4	2.5
Oil	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	1.6	1.2	1.4	1.3
Total	0.9	0.9	0.9	1.0	1.0	0.9	0.9	1.0	2.7	3.6	4.7	3.5	3.7	3.8
Net imports														
Solid fuels:	15.2	14.5	15.8	19.6	18.3	15.6	16.2	19.8	56.4	62.1	59.4	58.7	65.0	69.9
Hard coal	14.9	14.7	15.4	18.2	17.1	15.8	15.9	18.6	55.8	62.3	59.3	57.7	63.2	67.5
Oil	83.2	86.5	94.3	96.4	92.1	95.2	89.7	92.6	349.8	333.3	356.2	355.9	360.4	369.6
Natural gas	19.0	17.8	15.4	19.1	20.4	19.1	16.2	20.0	57.3	59.4	64.8	71.8	71.3	75.8
Electricity	0.3	0.7	0.8	0.4	0.3	0.9	0.9	0.5	1.5	1.2	1.3	1.6	2.3	2.7
Total	117.7	119.4	126.4	135.5	131.2	130.8	123.1	132.9	465.1	456.0	481.6	488.0	499.0	518.0
Change in stocks														
Solid fuels:	—4.3	2.4	3.6	—1.6	—4.3	2.9	4.1	—1.6	—14.9	—5.0	6.2	—2.8	0.1	1.2
Hard coal	—4.2	2.5	3.1	—2.2	—4.7	2.8	3.7	—2.0	—12.2	—1.3	4.9	—3.9	—0.7	—0.2
Coke	—0.1	—0.1	0.5	0.6	0.5	0.1	0.5	0.5	—3.5	—2.6	1.5	0.9	0.9	1.5
Oil	—6.8	4.8	2.9	—2.1	—5.4	4.8	1.1	—3.0	—3.5	0.7	3.7	2.1	—1.2	—2.5
Natural gas	—6.4	3.6	3.3	—3.2	—6.4	2.5	3.1	—3.4	0.4	1.6	1.6	1.4	—2.8	—4.1
Total	—17.6	10.7	9.8	—6.9	—16.0	10.1	8.3	—7.9	—18.1	—2.7	11.6	0.8	—3.9	—5.4
Bunkers	7.3	7.3	7.8	8.1	7.8	7.9	7.7	7.6	23.8	26.2	30.5	29.5	30.4	30.9
Apparent gross consumption														
Solid fuels:	62.0	52.1	51.3	65.1	65.0	52.9	50.8	65.1	218.8	240.0	230.2	231.6	230.5	233.7
Hard coal	53.7	45.1	43.5	55.4	55.9	45.4	43.0	55.1	177.8	200.7	197.6	200.1	197.7	199.4
Coke	0.0	—0.2	—0.5	0.2	0.1	—0.3	—0.6	0.1	2.7	1.2	—2.6	—1.3	—0.4	—0.7
Lignite	8.3	7.2	8.2	9.5	9.0	7.8	8.3	9.9	38.3	38.1	35.2	32.8	33.3	35.0
Oil	121.3	110.7	117.6	127.3	127.0	118.0	118.6	126.1	475.3	455.9	473.7	473.4	476.9	489.7
Natural gas	65.5	37.3	30.8	58.4	70.2	41.1	30.8	57.6	176.2	184.5	186.8	198.9	192.0	199.7
Heat	38.9	33.2	32.9	39.9	41.8	36.2	35.1	41.1	97.8	126.0	134.4	138.3	144.9	154.2
Primary electricity	4.9	5.5	4.2	3.1	4.2	5.8	4.6	3.6	16.3	15.6	15.3	16.5	17.8	18.2
Other	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.5	1.6	1.7	1.7	1.7	1.8	1.9
Total	293.0	239.3	237.2	294.3	308.6	254.6	240.3	293.9	986.0	1 023.6	1 042.1	1 060.3	1 063.8	1 097.4
Adjustment to annual figures														
Solid fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	—1.1	1.2	0.9	0.0	0.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	—3.3	6.7	0.3	0.0	0.0	0.0
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2	0.1	0.0	0.0	0.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	—0.2	0.1	0.0	0.0	0.0
Primary electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	5.8	1.7	0.9	0.0	0.0
Gross inland consumption														
Solid fuels	62.0	52.1	51.3	65.1	65.0	52.9	50.8	65.1	219.3	238.9	231.4	232.6	230.5	233.7
Oil	121.3	110.7	117.6	127.3	127.0	118.0	118.6	126.1	472.0	462.6	474.0	473.4	476.9	489.7
Natural gas	65.5	37.3	30.8	58.4	70.2	41.1	30.8	57.6	176.7	184.7	186.9	198.9	192.0	199.7
Heat	38.9	33.2	32.9	39.9	41.8	36.2	35.1	41.1	104.5	125.7	134.5	138.3	144.9	154.2
Primary electricity	4.9	5.5	4.2	3.1	4.2	5.8	4.6	3.6	16.6	15.8	15.4	16.5	17.8	18.2
Other	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.5	1.6	1.7	1.7	1.7	1.8	1.9
Total	293.0	239.3	237.2	294.3	308.6	254.6	240.3	293.9	990.7	1 029.4	1 043.8	1 061.3	1 063.8	1 097.4
Net imports as % of consumption														
Hard coal	27.7	32.6	35.5	32.9	30.6	34.7	37.1	33.8	31.4	31.0	30.0	28.8	32.0	33.8
Oil	64.7	73.3	75.2	71.2	68.3	75.6	71.1	69.3	70.1	69.1	70.6	70.8	71.0	71.0
Natural gas	28.9	47.7	50.1	32.7	29.1	46.5	52.8	34.7	32.5	32.2	34.7	36.1	37.1	37.9
Total	39.2	48.4	51.6	44.8	41.4	49.9	49.6	44.1	46.1	43.4	44.9	44.8	45.6	45.9
Oil imports as % of total energy consumption	27.7	35.1	38.5	31.9	29.1	36.3	36.2	30.7	34.6	31.7	33.2	32.7	32.9	32.8

Table 5 - EUR 12
Oil and natural gas: Supply and disposal
(Last revision: 17 November 1988)

									Year					
	1 Q 88	2 Q 88	*3 Q 88*	*4 Q 88*	*1 Q 89*	*2 Q 89*	*3 Q 89*	*4 Q 89*	1984	1985	1986	1987	*1988*	*1989*
1. Oil (million tonnes)														
Primary production	38.1	35.8	*33.6*	*36.5*	*36.8*	*35.1*	*37.2*	*37.7*	144.2	147.9	150.0	147.5	*144.0*	*146.8*
of which: crude	36.6	34.5	*32.2*	*34.9*	*35.2*	*33.6*	*35.6*	*36.0*	140.3	144.2	143.7	141.2	*138.3*	*140.4*
Change in stocks	—7.0	4.9	*2.9*	*—2.1*	*—5.4*	*4.8*	*1.1*	*—3.0*	—3.5	0.7	3.8	2.2	*—1.3*	*—2.5*
Net imports	83.1	86.3	*93.5*	*95.7*	*91.4*	*94.4*	*89.0*	*91.8*	349.5	332.6	355.4	355.1	*358.5*	*366.7*
Bunkers	7.5	7.5	*8.0*	*8.3*	*8.1*	*8.1*	*7.9*	*7.8*	24.5	27.0	31.4	30.4	*31.4*	*31.9*
Apparent consumption	120.6	109.8	*116.2*	*125.9*	*125.6*	*116.7*	*117.2*	*124.7*	472.7	452.9	470.2	470.0	*472.4*	*484.1*
Adjustment	0.0	0.0	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	—2.3	7.3	0.7	0.0	*0.0*	*0.0*
Gross inland consumption	120.6	109.8	*116.2*	*125.9*	*125.6*	*116.7*	*117.2*	*124.7*	470.4	460.1	470.9	470.0	*472.4*	*484.1*
Transformation input	125.2	124.6	*131.2*	*135.2*	*132.9*	*129.1*	*130.3*	*130.4*	517.7	492.1	515.6	507.5	*516.2*	*522.6*
of which:														
Refineries	115.0	116.0	*121.6*	*122.4*	*120.0*	*120.7*	*120.8*	*118.0*	462.3	448.9	476.1	467.0	*474.9*	*479.5*
Power generation	9.7	8.1	*9.1*	*12.3*	*12.3*	*7.9*	*9.0*	*11.9*	52.9	41.1	37.3	38.4	*39.2*	*41.1*
Refineries gross output	114.5	115.2	*121.0*	*121.7*	*119.9*	*120.3*	*120.5*	*117.5*	456.6	444.6	473.1	464.2	*472.5*	*478.2*
Refineries consumption	7.0	6.7	*7.0*	*7.3*	*7.2*	*7.2*	*7.2*	*7.4*	25.7	24.8	27.4	27.2	*28.0*	*29.0*
Refineries net output	107.5	108.5	*114.1*	*114.4*	*112.7*	*113.1*	*113.2*	*110.2*	430.9	419.8	445.7	437.0	*444.5*	*449.2*
Avail. final consumption	102.9	93.7	*99.0*	*105.1*	*105.4*	*100.7*	*100.1*	*104.5*	383.5	387.8	401.0	399.5	*400.7*	*410.7*
Final consumption (est.)	102.4	97.5	*99.8*	*105.7*	*105.4*	*101.4*	*100.9*	*105.0*	390.1	386.0	401.6	401.6	*405.3*	*412.6*
Statistical difference	0.5	—3.8	*—0.7*	*—0.6*	*0.0*	*—0.8*	*—0.7*	*—0.5*	—6.6	1.9	—0.7	—2.1	*—4.6*	*—1.9*
Inland deliveries:														
Motor gasoline	23.5	25.6	*26.8*	*25.5*	*24.1*	*26.5*	*27.4*	*25.4*	91.6	91.2	95.5	97.9	*101.4*	*103.5*
Kerosenes	5.7	6.3	*7.0*	*6.3*	*6.1*	*6.6*	*7.3*	*6.4*	21.0	21.7	22.8	24.0	*25.3*	*26.4*
Gas/diesel oil-total	45.6	37.4	*39.7*	*46.7*	*47.6*	*40.7*	*40.5*	*46.6*	155.9	162.3	169.9	168.1	*169.4*	*175.5*
of which:														
Autom. diesel	17.8	18.8	*18.8*	*19.7*	*18.6*	*20.0*	*20.0*	*20.1*	49.6	60.8	65.8	69.7	*75.1*	*78.7*
Heating gasoil	27.8	18.6	*20.9*	*26.9*	*29.0*	*20.7*	*20.5*	*26.5*	106.3	101.4	104.1	98.4	*94.3*	*96.7*
Heavy fuel oil	17.1	15.5	*14.9*	*18.7*	*19.4*	*14.1*	*13.8*	*17.5*	98.2	78.1	74.2	70.5	*66.3*	*64.7*
Other products	20.6	21.3	*21.1*	*21.3*	*21.0*	*21.9*	*21.4*	*21.5*	78.9	76.0	78.8	81.7	*84.3*	*85.7*
Total	112.6	106.1	*109.4*	*118.5*	*118.2*	*109.8*	*110.3*	*117.4*	445.6	429.2	441.1	442.1	*446.6*	*455.8*
2. Natural gas (million toe)														
Primary production	40.1	23.1	*18.7*	*36.0*	*43.4*	*24.5*	*17.7*	*34.2*	119.4	126.7	123.6	128.5	*117.9*	*119.8*
Change in stocks	—6.4	3.6	*3.3*	*—3.2*	*—6.4*	*2.5*	*3.1*	*—3.4*	0.4	1.6	1.6	1.4	*—2.8*	*—4.1*
Net imports	19.0	17.8	*15.4*	*19.1*	*20.4*	*19.1*	*16.2*	*20.0*	57.3	59.4	64.8	71.8	*71.3*	*75.8*
Apparent consumption	65.5	37.3	*30.8*	*58.4*	*70.2*	*41.1*	*30.8*	*57.6*	176.2	184.5	186.8	198.9	*192.0*	*199.7*
Adjustment	0.0	0.0	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.5	0.2	0.1	0.0	*0.0*	*0.0*
Gross inland consumption	65.5	37.3	*30.8*	*58.4*	*70.2*	*41.1*	*30.8*	*57.6*	176.7	184.7	186.9	198.9	*192.0*	*199.7*
of which:														
Power generation	6.2	5.3	*5.4*	*6.3*	*6.5*	*5.9*	*5.6*	*6.8*	24.8	22.7	21.9	23.3	*23.3*	*24.8*
Final consumption (est.)	56.4	30.4	*24.0*	*49.6*	*60.7*	*33.5*	*23.8*	*48.2*	145.6	154.8	156.8	167.0	*160.4*	*166.2*

Table 6 - EUR 12
Solid Fuels: Supply and disposal
(Last revision: 17 November 1988)

	1 Q 88	2 Q 88	3 Q 88	*4 Q 88*	*1 Q 89*	*2 Q 89*	*3 Q 89*	*4 Q 89*	Year 1984	1985	1986	1987	*1988*	*1989*
1. Hard coal (million tonnes)														
Primary production	55.4	52.7	49.9	*56.0*	*54.5*	*51.9*	*49.1*	*55.1*	172.6	217.5	228.2	221.8	*214.0*	*210.6*
Recovered production	1.3	1.2	*1.3*	*1.5*	*1.4*	*1.3*	*1.3*	*1.4*	5.4	7.4	6.8	5.1	*5.2*	*5.5*
Change in stocks:														
Collieries	—0.4	0.9	*2.2*	*—0.5*	*0.4*	*1.6*	*2.2*	*—0.9*	—8.0	—10.3	0.3	—2.8	*2.2*	*3.3*
Power plants	—6.8	3.4	*3.2*	*—3.2*	*—8.5*	*3.3*	*4.1*	*—2.5*	—13.0	8.1	8.2	—3.9	*—3.5*	*—3.6*
Total	—7.3	4.3	*5.4*	*—3.7*	*—8.1*	*4.9*	*6.3*	*—3.4*	—21.1	—2.2	8.4	—6.8	*—1.3*	*—0.4*
Net imports	23.0	22.7	*23.4*	*27.6*	*25.9*	*23.9*	*24.2*	*28.2*	86.4	96.4	91.7	89.3	*96.7*	*102.2*
Apparent consumption	86.9	72.3	*69.2*	*88.8*	*90.0*	*72.2*	*68.3*	*88.2*	285.5	323.5	318.3	322.9	*317.2*	*318.6*
Adjustment	0.0	0.0	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	—0.1	—1.8	1.1	—0.9	*0.0*	*0.0*
Gross inland consumption	86.9	72.3	*69.2*	*88.8*	*90.0*	*72.2*	*68.3*	*88.2*	285.4	321.7	319.4	322.0	*317.2*	*318.6*
Transformation input	77.3	60.8	*59.2*	*76.5*	*78.8*	*61.8*	*58.1*	*75.7*	245.7	272.8	277.0	279.3	*273.8*	*274.4*
of which:														
Power generation	58.9	43.1	*41.6*	*59.2*	*60.9*	*44.2*	*40.9*	*58.9*	167.9	188.1	195.5	204.5	*202.9*	*204.9*
Coke	17.8	16.9	*16.8*	*16.3*	*17.0*	*16.8*	*16.4*	*15.8*	75.1	81.3	78.1	71.7	*67.8*	*66.0*
Production patent fuels	0.6	0.5	*0.6*	*0.9*	*0.8*	*0.6*	*0.6*	*0.9*	3.1	3.6	3.2	3.0	*2.7*	*2.9*
Avail. final consumption	10.2	12.0	*10.6*	*13.2*	*11.9*	*11.1*	*10.8*	*13.4*	42.7	52.5	45.5	45.7	*46.0*	*47.2*
Final consumption (est.)	11.9	10.3	*10.6*	*13.2*	*11.9*	*11.1*	*10.8*	*13.4*	41.1	50.2	45.3	46.6	*46.0*	*47.2*
Industry	7.1	6.6	*6.9*	*8.1*	*7.0*	*7.1*	*7.2*	*8.4*	22.0	28.3	24.0	27.6	*28.7*	*29.6*
Domestic	4.8	3.7	*3.8*	*5.1*	*4.9*	*4.0*	*3.7*	*5.0*	19.0	21.9	21.3	19.0	*17.4*	*17.6*
Statistical difference	—1.7	1.7	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	1.7	2.3	0.2	—0.9	*0.0*	*0.0*
Deliveries of hard coal to:														
Power plants	50.9	45.4	*43.5*	*54.4*	*51.1*	*46.1*	*43.5*	*54.8*	146.5	189.2	195.3	194.9	*194.2*	*195.5*
Coking plants	17.8	16.9	*16.8*	*16.3*	*17.0*	*16.8*	*16.4*	*15.8*	75.1	81.3	78.1	71.7	*67.8*	*66.0*
Patent plants	0.6	0.7	*0.7*	*1.0*	*0.9*	*0.8*	*0.8*	*1.1*	2.8	3.4	3.4	3.0	*3.1*	*3.5*
All industries	7.9	7.5	*7.9*	*9.4*	*8.1*	*8.2*	*8.3*	*9.7*	28.8	33.6	30.9	31.9	*32.6*	*34.2*
Households	4.2	3.2	*3.1*	*4.2*	*4.2*	*3.4*	*3.0*	*4.1*	16.0	18.3	18.1	16.0	*14.7*	*14.7*
Other	0.4	0.3	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	1.6	1.8	1.4	1.5	*1.3*	*1.2*
Total	81.7	74.0	*72.4*	*85.6*	*81.4*	*75.5*	*72.3*	*85.7*	270.7	327.5	327.3	318.9	*313.7*	*315.0*
Power sector:														
Deliv. to power plants	50.9	45.4	*43.5*	*54.4*	*51.1*	*46.1*	*43.5*	*54.8*	146.5	189.2	195.3	194.9	*194.2*	*195.5*
Industry	1.2	1.1	*1.3*	*1.6*	*1.4*	*1.4*	*1.4*	*1.7*	8.3	7.1	8.4	5.7	*5.2*	*5.8*
Total	52.0	46.5	*44.8*	*56.0*	*52.4*	*47.5*	*44.9*	*56.4*	154.9	196.2	203.7	200.6	*199.4*	*201.3*
Change in stocks	—6.8	3.4	*3.2*	*—3.2*	*—8.5*	*3.3*	*4.1*	*—2.5*	—13.0	8.1	8.2	—3.9	*—3.5*	*—3.6*
Consumption in power stations	58.9	43.1	*41.6*	*59.2*	*60.9*	*44.2*	*40.9*	*58.9*	167.9	188.1	195.5	204.5	*202.9*	*204.9*
2. Hard coke (million tonnes)														
Coking plants														
Production	13.0	12.9	*12.8*	*12.8*	*12.8*	*12.8*	*12.5*	*12.4*	56.2	60.8	58.4	53.8	*51.5*	*50.6*
Change in stocks	—0.1	—0.2	*0.8*	*0.9*	*0.7*	*0.1*	*0.7*	*0.7*	—5.2	—3.9	2.2	1.4	*1.4*	*2.3*
Deliveries to the iron and steel industry	11.1	11.2	*10.7*	*10.8*	*10.9*	*10.9*	*10.3*	*10.4*	52.1	53.2	47.9	44.9	*43.9*	*42.6*
3. Lignite (million tonnes)														
Production	44.1	39.5	*43.3*	*49.0*	*46.4*	*42.5*	*44.0*	*50.8*	196.0	186.9	183.1	175.2	*175.9*	*183.7*
Consumption in power stations	38.7	34.5	*38.1*	*44.5*	*41.5*	*37.2*	*38.9*	*46.6*	174.9	172.3	163.9	154.3	*155.8*	*164.1*

Notes:
[1] Final demand figures for hard coal include patent fuels.
[2] From 1987 Spanish black lignite ('negro') is included in hard coal figures.

Table 7 - EUR 12
Electricity: Generation and disposal
(Last revision: 17 November 1988)

	1 Q 88	2 Q 88	3 Q 88	4 Q 88	1 Q 89	2 Q 89	3 Q 89	4 Q 89	Year 1984	1985	1986	1987	1988	1989
1. Electrical power (TWh)														
A. Generation														
Total gross generation	463.5	387.6	374.7	463.8	485.3	406.1	386.8	475.0	1 499.9	1 571.1	1 611.0	1 658.5	1 689.7	1 753.2
net of pumping	459.4	383.6	371.1	459.8	481.2	402.0	383.3	471.2	1 482.9	1 552.3	1 593.7	1 642.4	1 674.0	1 737.7
of which:														
Primary:	53.4	56.5	38.9	31.2	44.4	56.9	42.8	35.6	172.1	167.4	163.2	172.8	180.0	179.8
Hydro (net of pumping)	52.6	55.7	38.2	30.5	43.6	56.2	42.1	34.9	169.3	164.7	160.4	169.8	177.0	176.8
Geothermal	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	2.8	2.7	2.8	3.0	3.1	3.0
Derived:	406.1	327.1	332.2	428.6	436.8	345.1	340.5	435.5	1 310.8	1 384.9	1 430.5	1 469.5	1 494.0	1 557.9
Nuclear	152.8	129.3	127.6	156.6	164.5	141.2	136.9	161.9	399.0	483.2	522.5	538.2	566.3	604.4
Conventional thermal	253.2	197.8	204.6	272.0	272.4	203.9	203.5	273.7	911.7	901.7	908.1	931.4	927.7	953.5
Total net production	438.4	366.8	354.4	438.9	459.3	384.2	365.8	449.5	1 419.5	1 486.3	1 521.1	1 566.8	1 598.5	1 658.8
net of pumping	434.3	362.8	350.8	434.9	455.2	380.1	362.4	445.7	1 402.5	1 467.5	1 503.8	1 550.7	1 582.8	1 643.3
B. Disposal														
Total gross generation	463.5	387.6	374.7	463.8	485.3	406.1	386.8	475.0	1 499.9	1 571.1	1 611.0	1 658.5	1 689.7	1 753.2
Net imports	3.8	7.9	9.8	5.0	4.0	10.9	10.5	5.9	18.0	14.3	15.1	18.5	26.4	31.4
Gross inland consumption	467.4	395.5	384.5	468.8	489.4	417.0	397.3	481.0	1 517.9	1 585.4	1 626.1	1 677.0	1 716.1	1 784.6
Pumping	4.1	4.0	3.6	4.0	4.1	4.1	3.5	3.9	17.0	18.8	17.3	16.1	15.7	15.5
Production losses	25.1	20.8	20.3	24.9	26.0	21.9	20.9	25.5	80.4	84.8	89.9	91.6	91.2	94.4
Available for int. market	438.1	370.6	360.6	439.9	459.2	391.0	372.9	451.6	1 420.5	1 481.8	1 518.9	1 569.2	1 609.3	1 674.7
Distribution losses	29.8	24.9	25.8	31.5	32.9	28.3	26.9	32.6	95.6	103.9	103.2	106.7	112.0	120.7
Consumption internal market	408.3	345.7	334.9	408.4	426.3	362.7	345.9	419.0	1 324.9	1 377.9	1 415.7	1 462.6	1 497.2	1 554.0
Energy branch consumption	19.8	16.6	16.0	19.8	20.7	17.3	16.5	20.3	60.3	67.4	68.8	70.8	72.1	74.9
Final consumption (est.)	388.5	329.2	318.9	388.6	405.6	345.3	329.4	398.7	1 264.6	1 310.5	1 346.9	1 391.7	1 425.1	1 479.1
2. Input to conventional thermal power stations (million toe)														
Hard coal	34.0	24.9	24.0	34.2	35.2	25.5	23.6	34.0	96.9	108.6	112.9	118.1	117.1	118.3
Lignite	7.1	6.3	6.9	8.1	7.6	6.8	7.1	8.5	33.9	33.1	31.1	28.1	28.4	29.9
Petroleum products	9.3	7.7	8.7	11.7	11.8	7.5	8.6	11.4	50.6	39.3	35.6	36.7	37.5	39.3
Natural gas	6.2	5.3	5.4	6.3	6.5	5.9	5.6	6.8	24.8	22.7	21.9	23.3	23.3	24.8
Derived gas	1.5	1.5	1.5	1.6	1.4	1.5	1.5	1.6	5.4	5.5	5.9	5.5	6.1	6.0
Geothermal	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	2.2	2.1	2.2	2.3	2.4	2.5
Other	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.5	1.6	1.7	1.7	1.7	1.8	1.9
Total	59.1	46.8	47.6	63.0	63.6	48.2	47.4	63.4	215.4	213.0	211.2	215.7	216.6	222.7
3. Heat (TWh)														
Production nuclear heat	445.0	379.2	376.0	456.2	478.0	413.4	401.6	470.7	1 111.0	1 440.3	1 537.5	1 580.4	1 656.4	1 763.9
Production total heat	452.0	386.2	383.0	463.2	485.6	420.6	408.5	478.3	1 136.8	1 464.6	1 562.6	1 607.6	1 684.4	1 792.9
Adjustment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.9	—2.6	0.9	0.0	0.0	0.0
Gross consumption	452.0	386.2	383.0	463.2	485.6	420.6	408.5	478.3	1 214.7	1 462.0	1 563.5	1 607.6	1 684.4	1 792.9
Nuclear capacity (GW)	92.4	95.0	96.9	100.7	101.9	103.2	104.5	104.5	65.0	75.8	85.6	92.4	100.7	104.5

Table 8 - EUR 12
Main variables: growth rates from same quarter of previous year — in %
(Last revision: 17 November 1988)

	1 Q 87	2 Q 87	3 Q 87	4 Q 87	1 Q 88	2 Q 88	*3 Q 88*	*4 Q 88*	*1 Q 89*	*2 Q 89*	*3 Q 89*	*4 Q 89*
A. Specific units												
1. Hard coal												
Production	—2.6	—3.0	—4.2	—1.5	—4.5	—4.5	*—1.5*	*—3.3*	*—1.6*	*—1.6*	*—1.6*	*—1.6*
Net imports	2.6	—14.5	1.7	1.9	6.9	2.1	*3.4*	*20.4*	*12.8*	*5.3*	*3.3*	*2.2*
Apparent consumption	—4.3	0.7	5.3	5.5	—3.1	—2.9	*—2.6*	*1.3*	*3.5*	*0.0*	*—1.4*	*—0.7*
Gross inland consumption	—4.8	0.0	4.5	4.9	—2.9	—2.6	*—2.3*	*1.5*	*3.5*	*0.0*	*—1.4*	*—0.7*
Deliveries power plants	—0.6	—3.0	1.3	1.4	2.7	—3.3	*—4.7*	*3.3*	*0.4*	*1.5*	*0.1*	*0.6*
Deliveries coking plants	—10.6	—15.1	—4.4	—1.6	—2.0	—4.9	*—5.1*	*—9.6*	*—4.4*	*—0.6*	*—2.5*	*—3.3*
Deliveries all industries	—10.1	6.7	6.7	9.7	9.0	—5.1	*4.0*	*2.0*	*2.4*	*9.3*	*4.1*	*3.6*
Deliveries domestic	—12.6	—15.9	—22.8	0.9	—11.2	—11.3	*5.6*	*—10.7*	*—1.7*	*6.3*	*—2.4*	*—2.1*
Deliveries total	—4.7	—6.0	—1.0	1.5	1.0	—4.2	*—3.3*	*—0.3*	*—0.4*	*2.1*	*—0.1*	*0.1*
Transform. power gener.	—1.2	8.8	7.7	5.7	—2.6	—5.2	*—1.9*	*5.6*	*3.5*	*2.5*	*—1.9*	*—0.6*
2. Coke												
Production	—10.1	—8.2	—7.5	—5.3	—4.3	—5.0	*—3.9*	*—4.0*	*—2.0*	*—0.9*	*—1.9*	*—2.6*
Deliv. to iron and steel	—11.2	—7.5	—4.9	0.1	—1.9	—3.0	*—0.4*	*—3.8*	*—1.8*	*—2.8*	*—3.4*	*—3.6*
3. Lignite												
Production	—6.2	—2.5	5.5	—12.8	—4.1	—8.1	*—3.3*	*18.3*	*5.2*	*7.7*	*1.6*	*3.8*
Transform. power gener.	—7.1	0.1	2.2	—16.5	—6.3	—7.9	*—0.8*	*19.7*	*7.2*	*7.8*	*2.0*	*4.7*
4. Oil												
Production	—4.7	—3.4	—2.1	3.8	1.4	2.4	*—8.9*	*—4.1*	*—3.3*	*—2.1*	*10.7*	*3.3*
Net imports	2.9	—9.3	—1.7	9.2	—2.5	1.1	*0.4*	*4.6*	*10.0*	*9.4*	*—4.8*	*—4.0*
Apparent consumption	—1.1	—5.9	1.9	5.1	—0.4	—0.9	*0.5*	*2.7*	*4.1*	*6.3*	*0.9*	*—0.9*
Gross inland consumption	—1.2	—6.1	1.7	4.9	—0.4	—0.9	*0.5*	*2.7*	*4.1*	*6.3*	*0.9*	*—0.9*
Deliveries												
Motor gasoline	3.3	2.5	2.1	2.1	7.2	2.3	*2.5*	*2.8*	*2.6*	*3.7*	*2.3*	*—0.1*
Gas/diesel oil	—3.6	—10.7	3.4	7.8	—2.9	—0.7	*1.3*	*5.5*	*4.5*	*8.8*	*2.1*	*—0.2*
Autom. diesel oil	5.8	4.6	6.9	6.0	12.4	7.2	*5.0*	*7.2*	*4.6*	*6.4*	*6.6*	*1.7*
Heating gasoil	—7.8	—20.8	0.7	9.1	—10.7	—7.6	*—1.9*	*4.3*	*4.4*	*11.3*	*—2.0*	*—1.6*
Heavy fuel oil	1.2	—11.9	—6.3	—4.1	—17.1	1.0	*—7.1*	*1.9*	*13.2*	*—9.2*	*—7.4*	*—6.8*
Kerosenes	4.3	4.4	4.6	8.2	5.5	5.9	*5.0*	*4.4*	*5.8*	*5.5*	*4.5*	*2.2*
Other products	1.8	1.1	6.0	5.3	10.9	7.7	*—2.7*	*—1.6*	*1.8*	*2.8*	*1.4*	*0.7*
Total	—0.2	—5.1	2.1	4.0	—0.9	2.2	*—0.2*	*2.9*	*5.0*	*3.5*	*0.9*	*—0.9*
Transform. power gener.	15.8	9.0	—3.9	—6.9	—14.2	—0.9	*3.5*	*21.4*	*26.9*	*—2.8*	*—1.4*	*—3.2*
5. Natural gas												
Production	7.5	—0.3	—4.8	7.9	—14.0	—10.0	*—4.5*	*—1.7*	*8.3*	*6.3*	*—5.4*	*—5.1*
Net imports	11.9	22.7	—2.8	10.7	—3.5	—2.9	*12.5*	*—5.0*	*7.8*	*7.4*	*5.3*	*4.5*
Apparent consumption	8.5	5.4	—1.1	8.9	—10.4	—3.8	*5.4*	*0.9*	*7.2*	*10.2*	*0.0*	*—1.4*
Gross inland consumption	8.5	5.3	—1.2	8.9	—10.4	—3.8	*5.4*	*0.9*	*7.2*	*10.2*	*0.0*	*—1.4*
Transform. power gener.	19.2	21.5	—10.3	—4.0	—12.2	—2.9	*14.4*	*5.9*	*4.5*	*10.0*	*3.2*	*8.5*
Final consumption	7.4	3.0	0.9	10.6	—10.2	—3.9	*3.6*	*0.3*	*7.5*	*10.3*	*—0.8*	*—2.7*
6. Heat												
Production nuclear heat	5.9	—1.3	1.2	4.4	—0.2	7.7	*8.2*	*5.0*	*7.4*	*9.0*	*6.8*	*3.2*
7. Electricity												
Total gross generation	3.2	1.5	2.6	4.2	—1.1	1.7	*3.0*	*4.3*	*4.7*	*4.8*	*3.2*	*2.4*
Total net production	3.5	1.4	2.5	4.3	—1.1	1.9	*3.4*	*4.4*	*4.8*	*4.7*	*3.2*	*2.4*
Generation primary	—1.9	—14.8	10.2	47.2	34.0	20.8	*—2.5*	*—32.5*	*—16.8*	*0.8*	*10.0*	*14.1*
Generation derived	3.9	4.5	1.7	0.8	—4.5	—0.9	*3.9*	*8.7*	*7.6*	*5.5*	*2.5*	*1.6*
Generation nuclear	6.7	—1.0	1.8	3.6	—0.4	8.2	*8.5*	*6.1*	*7.6*	*9.1*	*7.3*	*3.4*
Generation conv.thermal	2.4	7.9	1.7	—0.8	—6.8	—6.1	*1.2*	*10.3*	*7.6*	*3.1*	*—0.5*	*0.6*
Gross inland consumption	3.2	0.8	3.4	4.9	—0.7	2.3	*3.3*	*4.7*	*4.7*	*5.4*	*3.3*	*2.6*
Available internal market	3.9	0.7	3.3	5.1	—0.8	2.6	*3.9*	*4.9*	*4.8*	*5.5*	*3.4*	*2.7*
Consumption intern. market	3.9	0.6	3.3	5.1	—0.8	2.7	*3.4*	*4.6*	*4.4*	*4.9*	*3.3*	*2.6*
Final consumption	3.9	0.6	3.4	5.1	—0.7	2.7	*3.4*	*4.6*	*4.4*	*4.9*	*3.3*	*2.6*
B. Toe												
Gross inland consumption												
Solids	—5.1	0.6	4.8	3.2	—2.8	—4.0	*—1.2*	*4.1*	*4.8*	*1.5*	*—1.0*	*—0.1*
Oil	—1.1	—6.0	1.7	5.0	—0.3	—0.9	*0.8*	*3.2*	*4.7*	*6.6*	*0.9*	*—0.9*
Natural gas	8.5	5.3	—1.2	8.8	—10.4	—3.8	*5.4*	*0.9*	*7.2*	*10.2*	*0.0*	*—1.4*
Heat	5.9	—1.2	1.3	4.4	—0.2	7.6	*8.0*	*5.1*	*7.4*	*8.9*	*6.7*	*3.2*
Primary electricity	—1.1	—17.2	15.5	55.2	37.2	23.5	*0.8*	*—26.4*	*—15.3*	*5.4*	*9.5*	*14.7*
Total energy	1.0	—2.5	2.2	5.8	—2.8	—0.5	*1.9*	*2.7*	*5.3*	*6.4*	*1.3*	*—0.1*

Table 9 - EUR 12
Main variables: year to date growth rates — in %
(Last revision: 17 November 1988)

	1 Q 87	2 Q 87	3 Q 87	4 Q 87	1 Q 88	2 Q 88	*3 Q 88*	*4 Q 88*	*1 Q 89*	*2 Q 89*	*3 Q 89*	*4 Q 89*
A. Specific units												
1. Hard coal												
Production	—2.6	—2.8	—3.3	—2.8	—4.5	—4.5	*—3.6*	*—3.5*	*—1.6*	*—1.6*	*—1.6*	*—1.6*
Net imports	2.6	—6.9	—4.1	—2.7	6.9	4.5	*4.1*	*8.3*	*12.8*	*9.1*	*7.1*	*5.7*
Apparent consumption	—4.3	—2.1	0.0	1.4	—3.1	—3.0	*—2.9*	*—1.8*	*3.5*	*1.9*	*0.9*	*0.4*
Gross inland consumption	—4.8	—2.7	—0.6	0.8	—2.9	—2.8	*—2.6*	*—1.5*	*3.5*	*1.9*	*0.9*	*0.4*
Deliveries power plants	—0.6	—1.8	—0.8	—0.2	2.7	—0.3	*—1.7*	*—0.3*	*0.4*	*0.9*	*0.7*	*0.7*
Deliveries coking plants	—10.6	—12.9	—10.3	—8.2	—2.0	—3.4	*—4.0*	*—5.4*	*—4.4*	*—2.5*	*—2.5*	*—2.7*
Deliveries all industries	—10.1	—2.1	0.7	3.1	9.0	1.7	*2.5*	*2.3*	*2.4*	*5.8*	*5.2*	*4.8*
Deliveries domestic	—12.6	—14.1	—16.5	—12.1	—11.2	—11.2	*—6.8*	*—8.0*	*—1.7*	*1.8*	*0.5*	*—0.2*
Deliveries total	—4.7	—5.3	—4.0	—2.5	1.0	—1.5	*—2.1*	*—1.6*	*—0.4*	*0.8*	*0.5*	*0.4*
Transform. power gener.	—1.2	2.9	4.2	4.6	—2.6	—3.7	*—3.2*	*—0.8*	*3.5*	*3.1*	*1.7*	*1.0*
2. Coke												
Production	—10.1	—9.2	—8.6	—7.8	—4.3	—4.6	*—4.4*	*—4.3*	*—2.0*	*—1.4*	*—1.6*	*—1.8*
Deliv. to iron and steel	—11.2	—9.4	—8.0	—6.1	—1.9	—2.5	*—1.8*	*—2.3*	*—1.8*	*—2.3*	*—2.7*	*—2.9*
3. Lignite												
Production	—6.2	—4.5	—1.3	—4.3	—4.1	—6.0	*—5.1*	*0.4*	*5.2*	*6.4*	*4.7*	*4.5*
Transform. power gener.	—7.1	—3.8	—1.9	—5.9	—6.3	—7.1	*—5.0*	*0.9*	*7.2*	*7.5*	*5.6*	*5.4*
4. Oil												
Production	—4.7	—4.1	—3.4	—1.7	1.4	1.9	*—1.7*	*—2.4*	*—3.3*	*—2.7*	*1.5*	*1.9*
Net imports	2.9	—3.6	—2.9	—0.1	—2.5	—0.7	*—0.3*	*1.0*	*10.0*	*9.7*	*4.6*	*2.3*
Apparent consumption	—1.1	—3.4	—1.7	0.0	—0.4	—0.6	*—0.3*	*0.5*	*4.1*	*5.1*	*3.7*	*2.5*
Gross inland consumption	—1.2	—3.6	—1.9	—0.2	—0.4	—0.6	*—0.3*	*0.5*	*4.1*	*5.1*	*3.7*	*2.5*
Deliveries												
Motor gasoline	3.3	2.8	2.6	2.5	7.2	4.6	*3.9*	*3.6*	*2.6*	*3.2*	*2.8*	*2.1*
Gas/diesel oil	—3.6	—6.9	—3.9	—1.1	—2.9	—1.9	*—0.9*	*0.8*	*4.5*	*6.4*	*5.0*	*3.6*
Autom. diesel oil	5.8	5.2	5.8	5.8	12.4	9.7	*8.0*	*7.8*	*4.6*	*5.5*	*5.9*	*4.8*
Heating gasoil	—7.8	—13.4	—9.7	—5.4	—10.7	—9.5	*—7.3*	*—4.2*	*4.4*	*7.1*	*4.3*	*2.6*
Heavy fuel oil	1.2	—4.8	—5.3	—5.0	—17.1	—9.4	*—8.7*	*—5.9*	*13.2*	*2.5*	*—0.6*	*—2.3*
Kerosenes	4.3	4.3	4.4	5.4	5.5	5.7	*5.5*	*5.2*	*5.8*	*5.7*	*5.2*	*4.5*
Other products	1.8	1.4	3.0	3.6	10.9	9.2	*4.9*	*3.2*	*1.8*	*2.3*	*2.0*	*1.7*
Total	—0.2	—2.6	—1.1	0.2	—0.9	0.6	*0.3*	*1.0*	*5.0*	*4.3*	*3.1*	*2.1*
Transform. power gener.	15.8	12.8	7.1	3.0	—14.2	—8.6	*—4.9*	*2.1*	*26.9*	*13.4*	*8.4*	*4.8*
5. Natural gas												
Production	7.5	4.5	2.4	3.9	—14.0	—12.6	*—10.9*	*—8.3*	*8.3*	*7.6*	*4.6*	*1.7*
Net imports	11.9	16.9	10.9	10.9	—3.5	—3.2	*1.0*	*—0.7*	*7.8*	*7.6*	*6.9*	*6.3*
Apparent consumption	8.5	7.4	5.5	6.5	—10.4	—8.1	*—5.3*	*—3.5*	*7.2*	*8.3*	*6.4*	*4.0*
Gross inland consumption	8.5	7.4	5.5	6.4	—10.4	—8.1	*—5.3*	*—3.5*	*7.2*	*8.3*	*6.4*	*4.0*
Transform. power gener.	19.2	20.2	10.0	6.0	—12.2	—8.1	*—2.0*	*0.0*	*4.5*	*7.0*	*5.8*	*6.5*
Final consumption	7.4	5.9	4.9	6.5	—10.2	—8.1	*—5.8*	*—4.0*	*7.5*	*8.5*	*6.5*	*3.6*
6. Heat												
Production nuclear heat	5.9	2.6	2.2	2.8	—0.2	3.3	*4.7*	*4.8*	*7.4*	*8.2*	*7.7*	*6.5*
7. Electricity												
Total gross generation	3.2	2.4	2.5	2.9	—1.1	0.1	*1.0*	*1.9*	*4.7*	*4.7*	*4.3*	*3.8*
Total net production	3.5	2.5	2.5	3.0	—1.1	0.2	*1.2*	*2.0*	*4.8*	*4.8*	*4.3*	*3.8*
Generation primary	—1.9	—9.3	—3.9	5.9	34.0	26.8	*17.6*	*4.2*	*—16.8*	*—7.8*	*—3.1*	*—0.1*
Generation derived	3.9	4.2	3.4	2.7	—4.5	—3.0	*—0.9*	*1.7*	*7.6*	*6.7*	*5.4*	*4.3*
Generation nuclear	6.7	3.2	2.8	3.0	—0.4	3.3	*4.9*	*5.2*	*7.6*	*8.3*	*8.0*	*6.7*
Generation conv. thermal	2.4	4.7	3.8	2.6	—6.8	—6.5	*—4.2*	*—0.4*	*7.6*	*5.6*	*3.7*	*2.8*
Gross inland consumption	3.2	2.1	2.5	3.1	—0.7	0.7	*1.5*	*2.3*	*4.7*	*5.0*	*4.5*	*4.0*
Available internal market	3.9	2.4	2.7	3.3	—0.8	0.7	*1.7*	*2.6*	*4.8*	*5.1*	*4.6*	*4.1*
Consumption intern. market	3.9	2.4	2.7	3.3	—0.8	0.8	*1.6*	*2.4*	*4.4*	*4.6*	*4.2*	*3.8*
Final consumption	3.9	2.4	2.7	3.3	—0.7	0.8	*1.6*	*2.4*	*4.4*	*4.6*	*4.2*	*3.8*
B. Toe												
Gross inland consumption												
Solids	—5.1	—2.6	—0.4	0.5	—2.8	—3.4	*—2.7*	*—0.9*	*4.8*	*3.3*	*2.0*	*1.4*
Oil	—1.1	—3.5	—1.8	—0.1	—0.3	—0.6	*—0.1*	*0.7*	*4.7*	*5.6*	*4.0*	*2.7*
Natural gas	8.5	7.4	5.5	6.4	—10.4	—8.1	*—5.3*	*—3.5*	*7.2*	*8.3*	*6.4*	*4.0*
Heat	5.9	2.6	2.2	2.8	—0.2	3.2	*4.7*	*4.8*	*7.4*	*8.1*	*7.7*	*6.4*
Primary electricity	—1.1	—10.7	—3.3	7.1	37.2	29.6	*19.8*	*7.9*	*—15.3*	*—4.4*	*—0.4*	*2.3*
Total energy	1.0	—0.6	0.2	1.7	—2.8	—1.8	*—0.7*	*0.2*	*5.3*	*5.8*	*4.4*	*3.2*

Analysis of the forecasting record of the Commission of the European Communities

This article presents an analysis of the short-term energy forecasting record of the Commission of the European Communities (CEC). It covers the forecasts published during the last four years in *Energy in Europe*.

The short-term energy outlook presents recent evolutions and short-term forecasts for a large set of energy variables including prices, demand, production and net imports by fuel for the full Community. It is the only short-term energy forecast published in Europe by a non-private organization and accessible to a large audience. Up to now, 13 forecasts have been published (including the one in this issue), with an average frequency of three per year.

The article contains an error analysis of the forecasts for the main variables, comparing them to actual statistical data for the years 1984 to 1987.

The energy forecasts

The forecasts published in *Energy in Europe* are generally presented on a quarter by quarter basis and cover, mainly, the following fuels:

(a) solid fuels (hard coal, coke, lignite);
(b) oil;
(c) natural gas;
(d) electricity.

For each fuel, the principal variables examined are:

(i) prices;
(ii) production;
(iii) net imports;
(iv) change in stocks;
(v) apparent gross inland consumption;
(vi) final consumption and/or deliveries.

For the electricity sector the structure of production is also estimated. Finally, a global balance sheet for primary energy (in million tonnes of oil equivalent-Mtoe) is presented.

The statistical basis for this outlook is, primarily, the database of monthly statistics, maintained and published by the Statistical Office of the European Communities (SOEC).

The forecasts are made at the EUR 12 level using three sources of input:

(i) A short-term econometric model (STEM), describing the European energy market.

(ii) Discussions and advice by experts of each fuel within DG XVII.

(iii) Different market information and opinions, gathered in an informal way by DG XVII.

The typical forecast horizon into the future, varies between 3 and 7 quarters. However, due to the delays in the statistical system, a first estimation for a given quarter is known, for the majority of variables, with an average delay of five months. That means, in practice, that the two latest quarters prior to publication are also forecasts. For example, the latest known quarter at November 1988, is the second quarter of 1988.

The following table summarizes the characteristics of the forecasts analysed in this paper.

Table 1: Summary of forecasts

				Latest known			Forecast horizon (quarters[1])			
EE	Date	Manuscript	Coverage	Quarter	Year	Last	Year t—1	Year t	Year t+1	Year t+2
No 0	12/1984	30/10/1984	EUR 10	2 q 84	1983	4 q 85	—	2	6	—
No 1	4/1985	29/3/1985	EUR 10	4 q 84	1984	4 q 85	—	0	4	—
No 2	8/1985	13/8/1985	EUR 10	1 q 85	1984	4 q 86	—1	3	7	—
No 3	12/1985	29/11/1985	EUR 10	2 q 85	1984	4 q 86	—	2	6	—
No 4	4/1986	17/4/1986	EUR 10	4 q 85	1985	4 q 86	—	0	4	—
No 5	9/1986	6/8/1986	EUR 10	1 q 86	1985	4 q 87	—	—1	3	7
No 6	12/1986	22/12/1986	EUR 10	3 q 86	1985	4 q 87	—	1	5	—
No 7	7/1987	30/4/1987	EUR 10	4 q 86	1986	4 q 87	—	0	4	—
No 8	10/1987	10/9/1987	EUR 10	1 q 87	1986	4 q 88	—	—1	3	7
No 9	12/1987	23/11/1987	EUR 12	2 q 87	1986	4 q 88	—	2	6	—
No 10	4/1988	26/2/1988	EUR 12	3 q 87	1986	4 q 88	—	1	5	—
No 11	9/1988	17/6/1988	EUR 12	4 q 87	1987	4 q 88	—	0	4	—
No 12	12/1988	30/11/1988	EUR 12	2 q 88	1987	4 q 89	—	2	6	—

[1] Only primary energy.

Some methodological questions

The different methodological questions related to general forecast error analysis are well known.[1] This analysis follows, in general, the methodology adopted by McNees. It is limited to the errors concerning the annual values of the different variables.

The issue of data revisions is frequently very significant in the energy field. Following the general practice, the predicted values are compared to the latest revision of actual data, considered as being the most accurate. The data used for this analysis are those available in mid-November 1988.

Four different measures of the average errors are presented. The exact formulas used and detailed results for more than 20 variables are given in the appendix.

The quality of a forecast is always relative. However, in this case there is not, to our knowledge, any other published error analysis for short-term energy forecasts in Europe, comparable to this one. Results from this analysis could be compared with published average errors of forecasts for macroeconomic variables.[2] However, due to the different nature of the fields covered, such a comparison would be of limited interest.

The exogenous variables and the oil price

The main exogenous variables used in any energy forecast are usually the level of the economic activity, the exchange rate, the weather conditions and the price of imported crude oil. The quality of the final result depends heavily on the quality of the assumptions made for the exogenous variables.

The overall economic activity in Europe from 1984 to 1987 as measured by the GDP growth rate was relatively calm with rates between 2.4% and 2.7% per annum. Table 2 shows that the errors in the assumptions for this area were relatively small.

This is not the case for oil prices, which fell from USD 28/b in 1985 to less than USD 14/b in 1986. This was an unprecedented phenomenon with major effects on the energy market. How well was the oil price forecast?

1 See, in particular, Keating (1985) and the different articles published by McNees (1978, 1981a, 1981b). Concerning econometric forecasts, see Klein and Young (1980) and Hirsch (1983).

2 For an analysis of forecasting errors in the macroeconomic fields, see among others, Su (1978) and McNees (1981b) for the US, Fontaineau (1982) for France, Wallis (1987) for the UK, and Llewellyn and Arai (1984) for the OECD and for international comparisons.

Table 2
GDP growth rate — Assumptions and errors

	1984	1985	1986	1987-EUR 10	1987-EUR 12
Observed (SOEC):	2.4	2.6	2.5	2.4	2.7
No 0	2.1	2.3			
No 1		2.4			
No 2		2.3	2.3		
No 3		2.3	2.5		
No 4			2.8		
No 5			2.7	2.8	
No 6			2.5	2.8	
No 7				2.1	
No 8				2.2	
No 9					2.2
No 10					2.4
Errors					
No 0	—0.3	—0.3			
No 1		—0.2			
No 2		—0.3	—0.2		
No 3		—0.3	0.0		
No 4			0.3		
No 5			0.2	0.4	
No 6			0.0	0.4	
No 7				—0.3	
No 8				—0.2	
No 9					—0.5
No 10					—0.3
Average error	—0.3	—0.3	0.1	0.1	—0.4
Average absol. error	0.3	0.3	0.1	0.3	0.4

Assumptions used for the 1986 oil price in successive forecasts are given in Table 3.

Table 3
Successive assumptions of the 1986 oil price (fob. USD/b)
Outcome: 13.7
Forecasts

EE	Date	Forecast	Error	Latest known month and 1986 observed average price	
No 2	August 1985	High : 26.5	12.8	26.2	(7/85)
		Low : 24.0	10.3		
No 3	November 1985	High : 25.0	11.3	27.1	(10/85)
		Low : 20.0	6.3		
No 4	April 1986	High : 20.0	6.3	15.6	(3/86)
		Low : 15.0	1.3	20.2	(1-3/86)
No 5	August 1986	13.2	—0.5	8.8	(7/86)
				15.1	(1-7/86)
No 6	December 1986	14.0	0.3	12.5	(11/86)
				13.8	(1-11/86)

Although a certain decline in prices was anticipated it is clear that the magnitude of the price collapse was not forecast before mid-1986.

Error analysis

Tables I to IV of the appendix provide a detailed error analysis by variable, according to the length of the forecast horizon in quarters.

Studying these tables leads to the following conclusions:

(a) The average absolute error (AAE) for total energy is not more than 1% (about 10 Mtoe). This can be considered as a very good overall performance given the uncertainty over the probable effects of price changes and the UK miners' strike, which occurred in 1984-85.

(b) With the exception of some variables, the forecasts are unbiased. In other words, the average errors (AE) are much smaller than the AAE. The only variable that has almost always been overestimated is the production of hard coal. This error is not only a result of the UK strike as it goes on beyond 1985. It is interesting to note that the coal production is an exogenous variable in the STEM model.

(c) Judging by the results, the best forecasts, in specific units, are those concerning total electricity demand and production, followed by total oil production and deliveries. On the other hand, the less accurate forecasts are the ones referring to solid fuels and the fuel mix for electricity production.

(d) The results for the variables in the primary energy balance sheet, denoted in toe, show that oil is the best forecasted fuel.

Some specific examples

This general view hides some individual good or bad forecasts.

Some examples of accurate forecasts are:

(i) Deliveries of motor spirit, 1986
Actual: 88.2 Mt
Forecast 6 quarters before (EE No 3): 88.9 Mt

(ii) Deliveries of GDO, 1985
Actual: 149.3 Mt
Forecast 6 and 4 quarters before (Nos 0 and 1): 149.9 Mt

(iii) Deliveries of RFO, 1987 (EUR 10)
Actual: 61.2 Mt
Forecast 5 quarters before (No 6): 61.8 Mt

(iv) 1987 (EUR 12)
Actual: 70.5 Mt
Forecast 2 quarters before (No 9): 70.8 Mt

(v) Production of coke, 1987 (EUR 12)
Actual: 53.8 Mt
Forecast 2 quarters before (No 9): 53.9 Mt

(vi) Consumption of natural gas 1987 (EUR 12)
Actual: 198.9 Mtoe
Forecast: 2 quarters before (No 9): 198.5 Mtoe

(vii) Electricity gross generation, 1987 (EUR 12)
Actual: 1 658.5 Twh
Forecast 2 quarters before (No 9): 1 654.9 Twh

(viii) Electricity gross consumption, 1986
Actual: 1 476.0 Twh
Forecast 6 quarters before (No 3): 1 477.7 Twh

(ix) Total energy consumption, 1986
Actual: 961.3 Mtoe
Forecast 7 quarters before (No 2): 964.0 Mtoe

Some inaccurate forecasts:

(i) Electricity production, nuclear, 1987 (EUR 10)
Actual: 466.5 Twh
Forecast 5 quarters before (No 6): 541.7 Twh

(ii) Hard coal production, 1985
Actual: 201.0 Mt
Forecast 6 quarters before (No 0): 229.7 Mt

Learning from errors

Are the forecasts published in the latest issues 'better' than those published earlier? In other words, how much has been learnt from previous errors?

There is no clear answer to this question. No clear pattern emerges when comparing the average absolute errors, after adjustment due to data revisions, over time (Table 4).

(a) With some exceptions (for example deliveries of GDO and nuclear), the results for 1986 are better than those of 1985; for 21 out of 26 variables presented in Table 4, the errors are smaller in 1986. It seems that there is a clear progress after the first 2-3 forecasts.

(b) Unfortunately, the results for 1987 (EUR 10) are clearly less satisfactory. The errors for almost all variables are higher than for 1986. This is probably explained by the fact that the STEM model has not been re-estimated before the enlargement to EUR 12.

(c) Results for EUR 12 are better than those for EUR 10 with only some exceptions (mainly hydroelectricity). However, this comparison is unfair because of the different length of forecast horizons.

Table 4
Average absolute errors for selected variables in percentage of actual values 1984-87

	1984	1985	1986	1987-10	1987-12
Number of forecasts before the publication of results for 4q	1	4	5	4	2
Average forecasting horizon (quarters)	2	3.75	4.2	4.75	1.5
Hard coal					
Production	7.5	5.1	3.1	4.4	1.1
Deliveries	2.8	3.6	2.6	2.0	0.6
Hard coke					
Production	4.0	4.9	1.3	3.2	0.2
Deliveries	2.9	1.7	6.6	10.1	1.2
Oil					
Production	1.7	1.6	1.3	0.8	1.2
Net imports	1.4	3.6	2.2	2.7	1.4
Deliveries MSP	1.1	2.9	1.3	0.5	0.4
Deliveries GDO	2.9	0.6	2.2	2.4	0.8
Deliveries RFO	3.9	5.8	2.5	3.5	0.7
Deliveries other	1.3	3.0	1.2	5.5	3.5
Deliveries Total	1.8	2.3	0.8	0.9	1.0
Natural gas					
Production	0.4	5.8	1.9	6.0	0.7
Consumption	2.9	1.4	0.7	4.9	1.3
Electricity					
Gross generation	1.4	0.5	0.4	0.7	0.1
Net generation	1.3	0.5	0.3	0.6	0.1
Hydro	3.0	7.0	3.7	4.1	9.5
Nuclear	3.4	2.6	6.1	10.9	0.7
Thermal	3.5	1.1	4.6	5.0	1.8
Gross consumption	1.4	0.5	0.2	0.4	0.2
Avail. int. market	1.4	0.5	0.4	0.5	0.4
Gross inland consumption - toe					
Solids	0.1	4.3	1.9	1.9	1.2
Oil	2.3	1.5	1.4	1.0	1.7
Natural gas	2.8	1.3	0.7	4.4	1.1
Nuclear	1.8	1.3	7.3	10.9	1.4
Electricity	6.3	10.7	6.2	15.0	13.7
Total	1.5	1.0	0.8	1.5	1.1

It seems however that we have, gradually, improved our understanding concerning price elasticities. As can be seen in Table 5, in our first issues we were continuously overestimating total energy demand for 1986 (issues Nos 2 to 6). The same error was made initially for 1987 (issues Nos 5 and 6). When, in April 1987, first estimations from the SOEC showed that the global energy demand during 1986 increased significantly less than 2% (latest SOEC estimation: 1.3%) we adapted gradually our perception concerning the relation between prices and demand. First provisional data for 1987 show, however, that in our latest issues we probably underestimated the medium-term effects of the oil price collapse by underestimating the 1987 growth of total energy demand (issues Nos 8 to 10). The same table proves that data revisions are usually important and can sometimes influence our forecasts.

Some conclusions

The results show that, overall, the forecasts can be considered as satisfactory. In particular, it seems that the forecasts made for 1986 were of very good quality.

Table 5
1986 - 87: Total gross inland consumption
Successive forecasts

Source	Date	1986 1985	1986	%	Error
observed — SOEC	Nov. 1988	948.8	961.3	1.3	
No 2	Aug. 1985	936.7	964.0	2.9	1.6
No 3	Dec. 1985	941.1	965.1	2.6	1.3
No 4	Apr. 1986	944.2	965.7	2.3	1.0
No 5	Sep. 1986	944.0	969.7	2.7	1.4
No 6	Dec. 1986	942.3	964.8	2.4	1.1
No 7	Jul. 1987	942.4	951.6	1.0	—0.3
No 8	Oct. 1987	942.4	951.6	1.0	—0.3
SOEC-Quarterly data	Apr. 1987	942.9	952.9	1.1	—0.2
SOEC-Rev.quart. data	Apr. 1988	942.9	960.1	1.8	0.5
SOEC-Balance sheets	Nov. 1987	943.8	959.7	1.7	0.4
SOEC-Yearbook	Dec. 1987	949.0	959.7	1.1	—0.2
SOEC-Revised	Feb. 1988	949.0	960.0	1.2	—0.1
SOEC-Latest	Nov. 1988	948.8	961.3	1.3	0.0

Source	Date	1987 1986	1987	%	Error
observed-SOEC-EUR 10	Nov. 1988	961.3	977.3	1.7	
observed-SOEC-EUR 12	Nov. 1988	1 043.7	1 062.6	1.8	
No 5 — EUR 10	Sep. 1986	969.7	997.5	2.9	1.2
No 6 — EUR 10	Dec. 1986	964.8	986.0	2.2	0.5
No 7 — EUR 10	Jul. 1987	951.6	963.0	1.2	—0.5
No 8 — EUR 10	Oct. 1987	951.6	955.0	0.4	—1.3
No 9 — EUR 12	Dec. 1987	1 043.5	1 049.9	0.6	—1.2
No 10 — EUR 12	Apr. 1988	1 039.5	1 048.1	0.8	—1.0
No 11 — EUR 12	Sep. 1988	1 044.2	1 057.3	1.3	—0.5
No 12 — EUR 12	Dec. 1988	1 043.8	1 061.3	1.7	—0.1
SOEC-Quart. data EUR 10	Apr. 1988	960.1	965.9	0.6	—0.7
SOEC-Quart. data EUR 12	Apr. 1988	1 042.8	1 051.7	0.9	—0.4
SOEC-Latest — EUR 10	Nov. 1988	961.3	977.3	1.7	0.0
SOEC-Latest — EUR 12	Nov. 1988	1 043.7	1 062.6	1.8	0.0

It is also clear that, in terms of relative errors, the best forecasts are those on electricity and oil. Forecasts of demand and production of solid fuels were less accurate.

The biggest error concerned early overestimation of nuclear energy for 1986 and especially for 1987.

Finally, the first results after the enlargement from EUR 10 to EUR 12 (EE No 9), appear to be very good.

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Appendix

Error tables — Methodology

If P : Predicted value (annual terms)
A : Actual value for latest available revision (annual terms)
A*: Estimate for A when the forecast was done (annual terms),
and
t : Actual forecast time
n : Forecast horizon, in quarters

then we have three types of errors:

E1 : Simple error, given by:

$$E1(t+n) = P(t+n) - A(t+n)$$

E2 : Error adjusted for data revision, given by:

$$E2(t+n) = P(t+n) - A(t+n) + A(t) - A^*(t)$$

E% : Error expressed in annual rates of growth, given by:

$$E\%(t+n) = [P(t+n) - P(t+n-1)]P(t+n-1) - [A(t+n) - A(t+n-1)]/A(t+n-1)$$

(forecast horizon more than 4 quarters)

or

$$E\%(t+n) = [P(t+n) - A^*(t+n-1)]/A^*(t+n-1) - [A(t+n) - A(t+n-1)]/A(t+n-1)$$

(forecast horizon less than 4 quarters)

The following tables are published:

Table I: Average errors adjusted for (A*-A) - conventional units

$$AE = \frac{1}{m} \sum E_2\,(t+n)$$

Table II: Average absolute errors adjusted for (A*-A) - conventional units

$$AAE = \frac{1}{m} \sum [E_2\,(t+n)]$$

Table III: Average absolute errors adjusted for (A*-A) in % of actual values

$$PAAE = \frac{1}{m} \sum \frac{[E_2\,(t+n)]}{A(t+n)}$$

Table IV: Average absolute errors — annual rates of growth — percentage points

$$AAE\ \% = \frac{1}{m} \sum [E\%\,(t+n)]$$

Table V: Actual values (A) — specific units

Table VI: Actual values (A) — Mtoe

Table 1:
Average errors — adjusted for (A - A:) — in conventional units

	Forecast horizon (quarters) 1	2	3	4	5-7	Average
Forecasts:	2	3	3	3	5	16
I. In specific units						
Hard coal (millions of tonnes)						
Production	4.0	4.9	2.0	2.2	17.7	7.1
Deliveries	4.0	−2.7	−2.9	−5.0	−0.9	−1.9
Coke (millions of tonnes)						
Production	−0.1	0.4	−1.1	−0.6	2.2	0.3
Deliveries	0.1	−1.0	0.5	2.8	4.0	1.6
Oil (millions of tonnes)						
Production	0.4	−0.7	0.3	1.9	−1.0	0.1
Net imports	2.0	−2.1	−3.0	−2.7	2.8	−0.6
Change in stocks	4.8	−5.1	−3.1	−3.3	0.2	−1.6
Deliveries						
Motor spirit	−0.3	0.5	0.3	0.6	1.6	0.7
Gas/Diesel	0.7	1.4	0.9	0.4	−0.8	0.4
Residual FO	1.8	2.4	2.2	1.5	1.4	1.9
Other	−1.5	−1.8	−2.3	1.2	−0.6	−1.0
Total	0.8	2.6	0.7	3.7	1.7	2.0
Natural gas (millions of toe)						
Production	−1.2	−1.5	−4.6	−5.5	−7.0	−4.3
Consumption	−3.7	0.7	−2.9	−3.9	−3.3	−2.6
Electricity (TWh)						
Gross generation	0.2	6.7	−6.2	−3.2	−1.7	−1.0
Net production						
Hydro	−5.3	−0.8	0.0	1.3	5.4	0.8
Nuclear	2.4	−6.1	21.4	18.8	32.8	15.9
Thermal	3.8	13.8	−26.0	−23.1	−39.0	−17.0
Total	0.3	4.2	−4.7	−3.1	−1.7	−1.1
Gross consumption	−0.4	6.1	−3.9	−8.2	2.1	−0.7
Avail. int. market	0.9	5.3	−0.6	−3.5	6.9	2.2
II. In millions of toe						
Gross inland consumption						
Solids	5.5	−1.0	−4.2	−3.8	−0.8	−1.2
Oil	−1.6	−0.8	−2.6	0.3	0.9	−0.5
Natural gas	−3.3	0.9	−2.9	−3.5	−3.7	−2.6
Nuclear	0.2	−1.7	5.9	4.7	12.8	5.7
Electricity	−1.0	−0.1	−0.4	−0.4	0.2	−0.2
Total	−0.2	−2.6	−4.2	−2.8	9.5	1.2

Table 2:
Average absolute errors — adjusted for (A - A:) — in conventional units

	Forecast horizon (quarters) 1	2	3	4	5-7	Average
I. In specific units						
Hard coal (millions of tonnes)						
Production	4.0	4.9	2.0	5.7	17.7	7.8
Deliveries	5.0	4.5	7.9	7.0	10.6	7.4
Coke (millions of tonnes)						
Production	0.2	1.0	1.1	1.4	2.8	1.5
Deliveries	0.9	1.0	1.3	2.8	4.0	2.2
Oil (millions of tonnes)						
Production	0.4	2.3	0.9	1.9	3.0	1.9
Net imports	4.1	4.9	5.7	13.5	8.5	7.6
Change in stocks	4.8	5.1	7.2	9.4	2.1	5.5
Deliveries						
Motor spirit	0.3	0.7	1.2	1.9	1.6	1.2
Gas/Diesel	0.7	2.8	2.5	2.6	3.6	2.6
Residual FO	1.8	2.5	2.2	2.4	2.3	2.3
Other	1.5	2.2	2.3	4.1	2.7	2.6
Total	2.0	7.4	5.0	5.7	5.1	5.3
Natural gas (millions of toe)						
Production	1.2	1.8	4.6	5.5	7.0	4.4
Consumption	3.7	2.7	2.9	3.9	4.9	3.7
Electricity (TWh)						
Gross generation	0.5	7.3	6.2	13.5	6.0	7.1
Net production						
Hydro	9.7	11.1	5.7	5.2	8.5	8.0
Nuclear	5.1	9.3	23.4	28.0	40.9	23.7
Thermal	14.8	14.9	26.0	23.1	43.5	26.4
Total	0.5	7.2	4.7	11.9	5.6	6.3
Gross consumption	4.4	7.6	5.3	8.2	3.7	5.8
Avail. int. market	6.5	9.2	7.4	5.7	6.9	7.2

Table 2 (contd)

	1	2	3	4	5-7	Average
II. In millions of toe						
Gross inland consumption						
Solids	5.5	1.9	6.1	6.3	5.3	5.0
Oil	3.9	7.4	4.2	3.5	8.7	6.0
Natural gas	3.3	2.5	2.9	3.6	5.3	3.7
Nuclear	2.7	1.7	5.9	6.1	13.3	7.0
Electricity	1.7	1.6	1.5	1.4	1.7	1.6
Total	10.2	11.7	13.0	8.8	9.5	10.5

Table 3:
Average absolute errors — adjusted for (A - A:) — in % of actual values

	Forecast horizon (quarter) 1	2	3	4	5-7	Average
Forecasts:	2	3	3	3	5	16
I. In specific units						
Hard coal (millions of tonnes)						
Production	1.9	2.9	1.0	2.8	8.7	3.9
Deliveries	1.7	1.6	2.7	2.3	3.6	2.5
Coke (millions of tonnes)						
Production	0.3	1.9	1.9	2.4	5.2	2.7
Deliveries	2.0	2.1	2.9	6.6	9.2	5.0
Oil (millions of tonnes)						
Production	0.2	1.6	0.6	1.3	2.1	1.3
Net imports	1.3	1.5	1.9	4.6	2.9	2.5
Deliveries						
Motor spirit	0.3	0.8	1.4	2.2	1.8	1.4
Gas/Diesel	0.4	1.9	1.6	1.7	2.3	1.7
Residual FO	2.7	3.4	3.5	3.8	3.5	3.4
Other	1.5	2.2	2.5	4.6	3.0	2.9
Total	0.5	1.8	1.3	1.5	1.3	1.3
Natural gas (millions of toe)						
Production	0.9	1.4	3.6	4.3	5.5	3.5
Consumption	1.9	1.5	1.5	2.0	2.6	1.9
Electricity (TWh)						
Gross generation	0.0	0.5	0.4	0.9	0.4	0.5
Net production						
Hydro	5.9	7.2	4.0	3.7	6.1	5.4
Nuclear	1.1	2.3	5.1	6.1	8.9	5.2
Thermal	1.7	1.8	3.3	2.9	5.5	3.3
Total	0.0	0.6	0.3	0.9	0.4	0.5
Gross consumption	0.3	0.5	0.4	0.6	0.3	0.4
Avail. int. market	0.5	0.7	0.5	0.4	0.5	0.5
II. In millions of toe						
Gross inland consumption						
Solids	2.5	0.9	2.8	2.9	2.5	2.3
Oil	0.8	1.7	1.0	0.8	2.1	1.4
Natural gas	1.7	1.4	1.5	1.8	2.8	2.0
Nuclear	2.0	1.5	4.7	4.9	10.5	5.6
Electricity	9.4	10.1	10.2	9.7	11.7	10.5
Total	1.0	1.2	1.4	0.9	1.0	1.1

Table 4:
Average absolute errors — Annual rates of growth — Percentage points

	Forecast horizon (quarters)							
	—1	0	1	2	3	4	5-7	Average 1-7
Forecasts:	3	4	2	3	3	3	5	16
I. In specific units								
Hard coal								
Production	1.0	0.8	1.8	1.9	1.2	3.2	6.8	3.3
Deliveries	1.2	1.2	1.7	1.4	2.7	2.6	2.7	2.3
Coke								
Production	0.1	0.1	0.3	1.9	2.0	2.5	4.5	2.5
Deliveries	0.1	2.0	1.8	2.3	2.7	6.1	10.0	5.1
Oil								
Production	1.0	0.6	0.2	1.7	0.6	1.3	1.8	1.2
Net imports	0.1	0.2	1.4	1.5	1.9	4.6	2.5	2.4
Deliveries								
Motor spirit	0.1	0.2	0.3	0.8	1.5	2.2	1.1	1.2
Gas/Diesel	0.4	0.2	0.4	1.9	1.6	1.7	3.0	1.9
Residual FO	1.2	1.4	2.6	3.0	3.0	3.3	3.8	3.2
Other	0.9	0.9	1.6	2.3	2.6	4.7	3.1	3.0
Total	0.2	0.2	0.5	1.8	1.3	1.5	1.7	1.4
Natural gas								
Production	0.7	0.4	1.0	1.5	3.8	4.5	4.2	3.2
Consumption	0.5	0.6	2.0	1.6	1.6	2.1	3.6	2.3
Electricity								
Gross generation	0.2	0.4	0.0	0.6	0.4	1.0	0.6	0.6
Net production								
Hydro	0.2	1.1	6.2	7.3	4.1	3.6	3.5	4.8
Nuclear	0.7	0.3	1.1	2.3	5.3	6.6	9.0	5.4
Thermal	0.2	0.4	1.7	1.5	3.3	3.0	5.1	3.1
Total	0.1	0.3	0.0	0.6	0.4	0.9	0.6	0.5
Gross consumption	0.2	0.3	0.3	0.6	0.4	0.6	0.3	0.4
Avail. int. market	0.1	0.2	0.5	0.7	0.6	0.4	0.2	0.5
II. In toe								
Gross inland consumption								
Solids	0.2	0.3	2.4	1.0	2.9	3.1	1.5	2.1
Oil	0.9	0.8	0.9	1.7	1.0	0.8	1.1	1.1
Natural gas	0.4	0.6	1.8	1.5	1.6	2.0	3.5	2.3
Nuclear	1.5	1.0	2.2	1.6	4.9	5.3	9.3	5.4
Electricity	0.9	1.6	10.6	10.5	11.1	10.6	8.6	10.1
Total	0.5	0.5	1.0	1.3	1.4	0.9	1.1	1.2

Table 6:
Actual values (November 1988) — millions of toe and growth rates in %

	EUR 10					EUR 12	
Gross consumption	1983	1984	1985	1986	1987	1986	1987
(mtoe)							
Solids	212.4	201.2	218.7	211.9	210.8	231.5	230.1
Oil	415.9	423.5	416.0	426.6	427.9	473.9	476.6
Gas	165.3	174.6	182.3	184.3	195.4	186.8	198.3
Nuclear	78.2	98.5	118.3	124.7	127.8	134.4	138.6
Electricity	13.6	12.8	12.0	12.3	13.5	15.4	16.8
Other	1.7	1.4	1.5	1.5	1.9	1.7	2.2
Total	887.1	912.0	948.8	961.3	977.3	1 043.7	1 062.6
(%)							
Solids		—3.3	8.7	—3.1	—0.9		—0.6
Oil		1.8	—1.8	2.5	0.3		0.6
Gas		5.6	4.4	1.1	6.0		6.2
Nuclear		26.0	20.1	5.4	2.5		3.1
Electricity		—5.9	—6.3	2.5	9.8		9.1
Total		2.8	4.0	1.3	1.7		1.8

Sources:
1983: *Eurostat Yearbook.* 1988
1984-86: SOEC, Unpublished revision of energy balance sheet, November 88.
1987: SOEC, Provisional estimates.

Table 5:
Actual values (November 1988) — specific units and growth rates in %

	EUR 10					EUR 12	
	1983	1984	1985	1986	1987	1986	1987
Hard coal (millions of tonnes)							
Production	235.2	157.1	201.0	211.8	202.2	228.2	221.8
%		—33.2	27.9	5.4	—4.5		—2.8
Deliveries	286.8	247.6	302.0	301.3	288.5	327.3	318.9
%		—13.7	22.0	—0.2	—4.2		—2.6
Coke (millions of tonnes)							
Production	53.5	52.8	57.1	55.0	50.7	58.4	53.8
%		—1.3	8.1	—3.7	—7.8		—7.9
Deliveries	41.8	48.5	49.9	44.7	42.1	47.9	44.9
%		16.0	2.9	—10.4	—5.8		—6.3
Oil (millions of tonnes)							
Production	130.1	141.7	145.5	146.3	144.4	150.0	147.5
%		8.9	2.7	0.5	—1.3		—1.7
Net imports	288.4	298.4	285.4	306.7	304.1	355.4	355.1
%		3.5	—4.4	7.5	—0.8		—0.1
Change in stocks	—17.9	—3.9	0.6	4.9	2.3	3.8	2.2
Deliveries motor spirit	83.7	85.2	84.4	88.2	90.1	95.5	97.9
%		1.8	—0.9	4.5	2.2		2.5
Deliveries GDO	140.4	143.2	149.3	156.8	154.5	169.9	168.1
%		2.0	4.3	5.0	—1.5		—1.1
Deliveries RFO	77.8	83.5	66.9	64.1	61.2	74.2	70.5
%		7.3	—19.9	—4.2	—4.5		—5.0
Deliveries other products	85.4	86.2	85.6	89.0	92.7	101.6	105.7
%		0.9	—0.7	4.0	4.2		4.0
Deliveries Total	387.3	398.1	386.2	398.0	398.6	441.1	442.1
%		2.8	—3.0	3.1	0.2		0.2
Natural gas (millions of toe)							
Production	119.9	119.2	126.5	123.3	127.9	123.6	128.5
%		—0.6	6.1	—2.5	3.7		4.0
Consumption	165.1	174.2	182.1	184.3	196.1	186.8	198.9
%		5.5	4.5	1.2	6.4		6.5
Electricity (Twh)							
Gross generation	1 299.8	1 360.7	1 425.3	1 462.9	1 505.0	1 611.0	1 658.5
%		4.7	4.7	2.6	2.9		2.9
Net generation	1 229.1	1 286.7	1 347.3	1 381.7	1 420.7	1 521.1	1 566.8
%		4.7	4.7	2.6	2.8		3.0
Hydro	144.8	141.5	137.7	140.2	146.8	163.2	172.8
%		—2.3	—2.7	1.8	4.7		5.9
Nuclear	275.0	352.8	429.4	456.1	466.5	522.5	538.2
%		28.3	21.7	6.2	2.3		3.0
Thermal	809.3	789.7	777.6	782.7	804.5	908.1	931.4
%		—2.4	—1.5	0.7	2.8		2.6
Gross consumption	1 321.6	1 375.6	1 438.4	1 476.0	1 522.1	1 626.1	1 677.0
%		4.1	4.6	2.6	3.1		3.1
Avail. int. market	1 237.9	1 287.5	1 344.2	1 378.8	1 422.8	1 518.9	1 569.2
%		4.0	4.4	2.6	3.2		3.3

Community news

Energy Council meeting, Brussels, 8 November 1988

'A decisive step has been taken towards the internal energy market', according to Mr Mosar, the Energy Commissioner, speaking after the 8 November Council meeting. The Energy Ministers adopted conclusions which represent a firm commitment to embarking on the path which the Commission had mapped out. The Council has therefore accepted the Commission's overall approach as set out in the Working Paper on the internal energy market which calls for progress in various fields: implementation of the 1985 White Paper, determined application of Community legislation, striking a balance between energy and environment, and specific action relating to energy costs, prices, tariffs and infrastructure.

After concluding that the internal energy market should contribute to establishing the single European market in 1992 and strengthening the achievements of Community energy policy, the Council highlighted certain specific aspects relating to the completion of the internal energy market, in particular the balance between energy and the environment, the development of infrastructure and the dissemination of new technologies.

The Council adopted conclusions in which it noted that, in spite of the fall in oil prices and a relaxed situation on the energy market, progress has been made in restructuring the energy sector. In a few areas, however, the objectives set may not be attained. The Council stressed in particular the need to continue efforts to search for balanced solutions as regards energy and the environment. It also reaffirmed the usefulness of developing the Community's external relations in the energy sector by virtue of a coordinated approach, in particular on the basis of regular consultations between Member States and the Commission.

The Council adopted a recommendation calling on the Member States to provide a framework for cooperation between public utilities and private generators who obtain their electricity from renewable energy sources, energy from waste or combined heat and power production, to facilitate the introduction of standard contract criteria, and to ensure that a number of conditions are laid down regarding the purchase by public utilities of certain quantities of electricity from such private generators and regarding the prices charged.

The Council had a general discussion concerning the oil market and the refining industry. Broad agreement was reached on the draft recommendation submitted to the Council. Only one point is still outstanding, namely the effect of environmental protection standards on refineries' production costs. This matter was finally referred to the Permanent Representatives Committee.

The Commission also submitted:

(i) the 1987 report on aid to the coal industry, and

(ii) a Community programme concerning the use of electricity.

European Parliament debates nuclear safeguards

British Nuclear Fuels' (BNFL's) reprocessing plant at Sellafield (UK) is a 'mixed' nuclear installation, with a dual civil and military function. For installations of this type, Community law provides for special safeguards arrangements to be made by the Commission with the consent of the Member State concerned. This procedure has been envisaged to enable the Community to apply safeguards to all civil material situated in these installations, while exempting material assigned to meet defence requirements.

Such special safeguards arrangements were made between the Commission and the UK early in 1986.

In April 1988, the European Parliament's Committee on Energy, Research and Technology submitted to the Parliament a draft resolution (rapporteur: Mr L. Smith) which criticized the Commission, *inter alia*, for failing to allow the European Parliament access to these safeguards techniques. The Commission's refusal to allow access was based on the confidentiality of procedures relating to safeguards of individual facilities, whether in a nuclear weapons State (NWS) or in a non-nuclear weapons State (NNWS), in the context both of Euratom and, at world level, of the IAEA.

More radically, the draft resolution called upon the Commission and the UK to seek to amend the tripartite Euratom/UK/IAEA Agreement in order to make it impossible for the UK to withdraw material from the civil cycle for defence purposes. This suggestion was opposed by the Commission as inconsistent both with the Euratom Treaty and with the international status of the UK as a NWS, under the Non-proliferation Treaty (NPT).

The draft resolution was debated in the plenary session of the European Parliament in Strasbourg on 26 October 1988. Following a vote it was not adopted.

During the debate the Commissioner for Energy, Mr Nic Mosar made a statement outlining the Commission's position on this matter. The text of the relevant part of the statement is reproduced below.

Statement by Mr Mosar

Mr President,

1. In the performance of its tasks the Commission handles a considerable amount of information. Where this information is of direct interest to the public it is desirable that it should circulate more freely. That is one of the lessons to be learned from your Parliamentary inquiry. I should also like to take this opportunity of repeating very clearly that the Commission will continue to supply Parliament with all the information which it can communicate without breaching the obligation of confidentiality which applies to certain data.

2. The question of confidentiality is a difficult one. It is at the heart of Mr Smith's motion for a resolution. My lengthy correspondence with Mr Poniatowski has made it possible, I hope, to remove a number of ambiguities. This evening I shall endeavour to remove any that might remain.

3. The Community is exclusively concerned with civil matters, so Euratom safeguards do not apply to military installations. In mixed installations, it is therefore important to ensure complete safeguards for the civil sector and to leave the defence sector out of the safeguards process.

4. To this end, it is up to the Commission, in consultation and agreement with the Member State concerned, to lay down appropriate safeguards procedures. This was done, not without difficulty, in the case of Sellafield in 1986. Since that time technical discussions have taken place in order to lay down in detail the special safeguards provisions. These discussions have in no way prevented inspections from taking place in the mixed installations at Sellafield for over two years.

5. The technical procedures relating to individual installations are, in the nature of things, confidential at world and Community level both for the countries which have nuclear weapons and for those which do not. This confidentiality is a result of obvious concerns with regard to physical protection and non-proliferation. It applies not only to the public or the press but also to the other Member States and the other institutions.

6. Having said that, I feel that I should draw Parliament's attention to the fact that in any case there can be no question of preventing nuclear materials which are not subject to a peaceful end-use obligation from being withdrawn from the safeguards arrangements so as to be used for defence purposes in a country with nuclear weapons. Such withdrawals are in fact perfectly permissible under the Euratom Treaty.

7. Mr President,

   I hope that the honourable Members will understand the reasons why it is impossible for the Commission to inform them of the technical safeguards procedures regarding Sellafield and why it cannot therefore support Mr Smith's resolution.

ECSC Consultative Committee

On 1 June the Committee heard a presentation on the Commission's review of Member States' energy policies, and discussed proposals for a new system of Community aid payments to redundant coal and steel workers under Article 56 ECSC.

On 20 June on the occasion of its 272nd session, the Committee was addressed by Commissioner Mosar on the subject of the internal energy market (this subject is treated in a special issue of *Energy in Europe*).

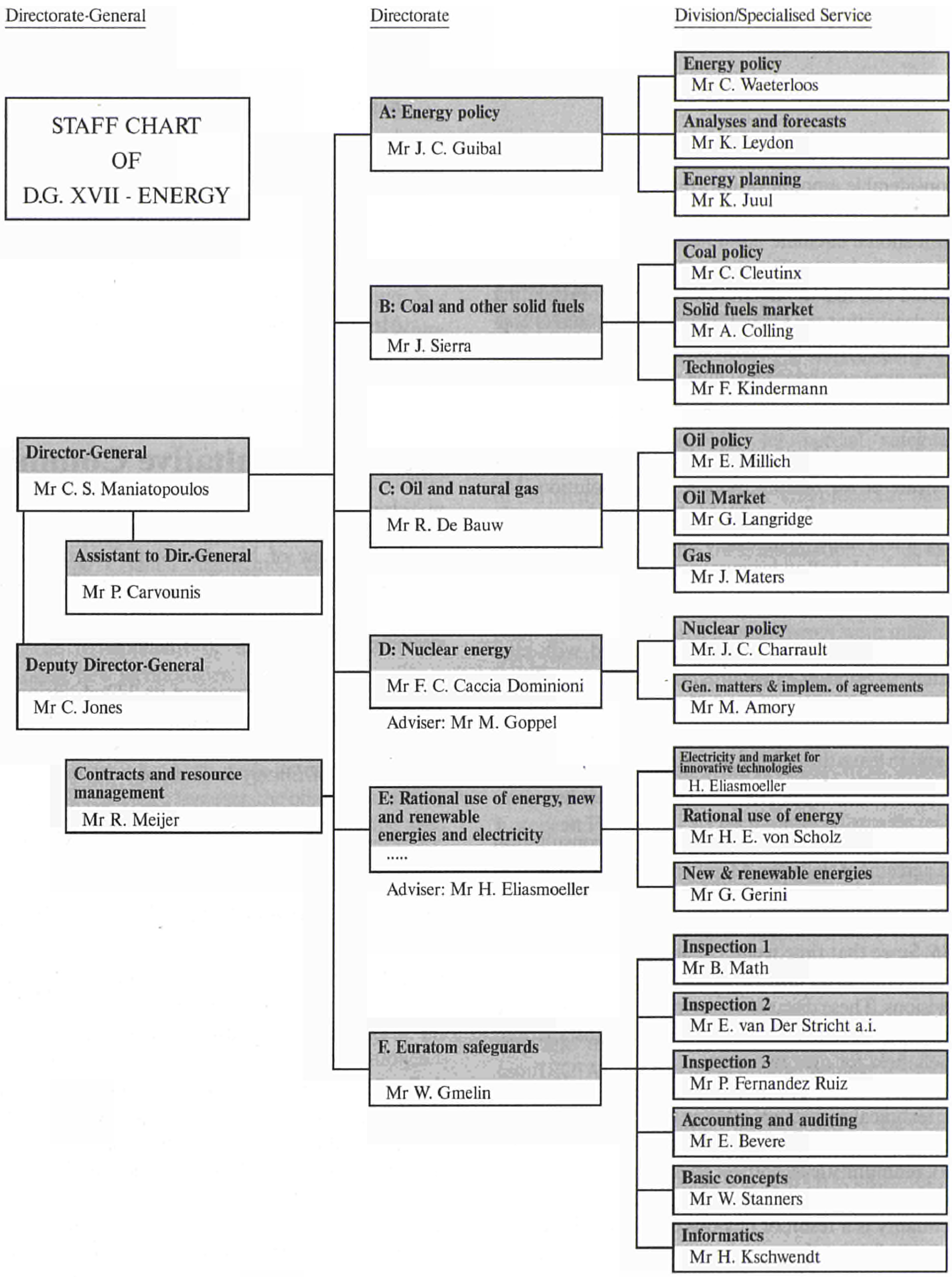
Michel Amory has retired

Michel Amory, Head of the Division 'Nuclear Energy — General matters and implementation of agreements', retired on 31 December 1988 after 28 years' service.

This will be a great loss for the Commission in general and for DG XVII in particular, as he is an eminent specialist in external relations in the nuclear field, an area to which he devoted his professional life in the service of the Community.

The area in question is a very complex, albeit exciting one, which demands many qualities, including a great capacity for analysis and synthesis as well as written and oral expression, a sense of proportion, *savoir faire*, plus of course a particularly solid and extensive basic preparation.

Michel Amory proved to have all these qualities, and more. Suffice it to recall, as regards his basic preparation, that before joining the Commission he was for several years a


Directorate-General
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Division/Specialised Service
STAFF CHART OF D.G. XVII - ENERGY
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Mr C. S. Maniatopoulos
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Mr P. Carvounis
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Energy policy
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Gas
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D: Nuclear energy
Mr F. C. Caccia Dominioni
Adviser: Mr M. Goppel
Nuclear policy
Mr. J. C. Charrault
Gen. matters & implem. of agreements
Mr M. Amory
E: Rational use of energy, new and renewable energies and electricity
.....
Adviser: Mr H. Eliasmoeller
Electricity and market for innovative technologies
H. Eliasmoeller
Rational use of energy
Mr H. E. von Scholz
New & renewable energies
Mr G. Gerini
F. Euratom safeguards
Mr W. Gmelin
Inspection 1
Mr B. Math
Inspection 2
Mr E. van Der Stricht a.i.
Inspection 3
Mr P. Fernandez Ruiz
Accounting and auditing
Mr E. Bevere
Basic concepts
Mr W. Stanners
Informatics
Mr H. Kschwendt

close collaborator of Mr Wigny, a very well-known Belgian politician who played an important part in setting up the European Communities. Endowed, moreover, with an extremely agreeable personality and inexhaustible faith in Europe, always enthusiastic and optimistic, Michel Amory will leave a lasting mark on the administration which he has left. Not only will he leave many friends behind but also 'pupils', i.e. officials who received their training by working with him. Thanks to his pupils Mr Amory will stay with us.

As far as he himself is concerned, he is already taking great pains to prepare himself actively not for retirement but for his new activities which will certainly include European Community affairs ...

So, Michel, farewell and thank you from all your colleagues for all that you have taught and given them.

Inauguration of a geothermal project in Greece

On the occasion of the completion of the geothermal project in Nea Kessani (Xanthi, Greece) the contractor, Hellenic Development Bank SA (ETBA) invited representatives of the Commission of the European Communities together with representatives of State, regional and local authorities to its inauguration. Mr Maniatopoulos (Director-General for Energy) led the Commission delegation while the chief representative from the State was Mr Vassilakos, the General Secretary of the Ministry of Energy. The inauguration took place on 16 and 17 May 1988.

The project mainly consists of a production well to a depth of 150 m which supplies 35 m^3/h of geothermal water at 72°C from a 37 m thick aquifer by means of an oil-lubricated 12 hp pump. The hot water is used to heat large greenhouse units. The main crop is tomatoes together with melons and water-melons. The geothermal water is later discharged at 30°C into a nearby river.

The total cost of the plant was around DRA 50 million (approximately ECU 330 000). The European Community provided financial assistance in the form of a grant of DRA 13.2 million (approximately ECU 88 000) under contract GE 632/83 (N. Kessani).

The annual energy saving of the geothermal project is approximately 220 toe.

Further information on the project can be obtained by writing to:
Directorate E, DG XVII-Energy, Commission of the European Communities, 200 rue de la Loi, B-1049 Brussels (or Telefax: Brussels 235 01 50).

Fifth international symposium on anaerobic digestion

Bologna, Italy 22 to 26 May 1988

As part of the Fifth International Symposium on Anaerobic Digestion, which was held at the Palazzo dei Congressi in Bologna from 22 to 26 May 1986, the 'Biomass and Energy from Waste' sector of DG XVII organized two workshops entitled:

(i) Problems and solutions in biogas plants;

(ii) Anaerobic treatment of chemically hazardous organic waste water.

The symposium opened with a preview showing of the film 'Anaerobic digestion', promoted by our DG and produced by the Scientific Cinematographic Section of the National Research Committee in Bologna with the help of Professor J.J. Nyns of the Biological Engineering Department of the University of Louvain-la-Neuve. An active part in the making of the film was also played by the FARE department of the ENEA (National Committee on Alternative Sources of Energy) in Bologna, along with contractors and research laboratories from several Member States.

The film was made in order to give all operators in the sector a clear picture of the results obtained in the demonstration programme. To give a better idea of the concepts involved and to complete the picture, an introduction was added on the basic phenomena of anaerobic digestion and current research at laboratory and pilot plant level.

The film, which was made in 16mm colour, will soon be available in video cassette format in five languages: English, French, German, Italian and Spanish.

The first showing was so successful that it was screened again on 25 May for those who had arrived too late to see it the first time. Copies have already been requested for showing in various countries. This film is now available for anyone wishing to show it with a view to promoting this technology further afield.

The two workshops, organized jointly with the Directorate-General for Science, Research and Development, were attended by a large number of delegates in addition to the contractors and speakers invited by the two DGs.

The conclusions presented by the rapporteurs at the end of the two workshops can be summarized as follows:

(i) aerobic digestion of organic effluent from the agri-foodstuffs industry has reached a good level of reliability. Given their contribution to environmental protection, such treatment processes are generally profitable;

(ii) anaerobic digestion of waste from stock farming, which is technically feasible without major problems, can be made economically attractive in large-scale cooperative plants. This type of centralized treatment is expanding rapidly in various countries, and the problems that can still arise centre largely on the marketing of the compost obtained and the full and optimum use of the biogas produced;

(iii) extraction of the biogas from landfills is spreading rapidly. The collecting techniques seem established. Some problems still remain in the control of impurities in the biogas, but the progress being made suggests increasingly widespread use;

(iv) anaerobic digestion of municipal waste is establishing itself as technically and economically feasible. This technology is very attractive for all countries that produce municipal waste with high organic content and need fertilizer and humus. Progress in the full-scale projects currently at the construction phase should soon show this technology to be reliable;

(v) anaerobic digestion of industrial waste contaminated by chemicals with varying degrees of stability, is now being thoroughly researched in a number of highly industrialized countries. Should it prove technically feasible, this method could make for the economically viable treatment of effluent from various highly polluting industries (paper, chemicals, pharmaceuticals, etc.). Laboratory, pilot or full-scale experiments in this sector are few and little known. Given the industrial interests at stake and the constantly rising cost of the treatments required to protect the environment, experimental work by companies or by universities for industrial concerns are not normally published. This specific sector is therefore of considerable common interest and demonstration projects are undoubtedly still necessary if these processes are to come in for more widespread use, not least in small and medium-sized industries producing this type of waste. The energy savings are certainly substantial, and a public campaign is still required if those industrial complexes which are now the only ones who can afford the research outlay are not to have a privileged position.

All in all, this Fifth International Symposium on Anaerobic Digestion confirmed that the process can make an effective contribution to the treatment of many types of waste.

The environmental and energy angles were highlighted once more by the many invited speakers at the two workshops run by the Commission. The discussions and conclusions will enable the Commission to define the guidelines for its own future action.

The changing atmosphere — implications for global security

The present climatic conditions on the earth are governed to a large extent by the composition of the atmosphere. Water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), ozone (O_3) and, recently, chlorofluorocarbons (CFCs) absorb part of the infrared radiation emitted by the earth and store it in the atmosphere. Man is modifying the composition of the atmosphere and concentrations of the so-called 'greenhouse gases' are increasing. Because of this, the thermal balance of the earth is being modified and global warming and climatic changes are happening or are expected to occur.

A conference on 'The changing atmosphere' was held in Toronto, Canada on 27 to 30 June 1988. The conference was organized by the Government of Canada as a follow-up to some of the conclusions and recommendations of the Brundtland Commission report and with the objective of launching a first initiative for policy action to combat the 'greenhouse effect'.

The conference was divided into two parts:

(i) presentations from scientists to give evidence on the present research findings concerning atmospheric damage and climate change; and

(ii) discussions in various working groups to finalize a number of statements which were incorporated in the final conference statement.

While the scientific presentations tried to avoid too much reference to results with a relatively high degree of uncertainty, it was agreed that on a scientific basis much uncertainty did exist. However, all the speakers considered the threat stemming from an increase in CO_2 and other trace gases to be substantial and definite enough to launch an international policy action programme.

During the conference, an 'Energy Working Group' was set up to focus discussions on two aspects of the 'greenhouse effect'. These were:

(i) definition of CO_2 reduction targets by improved energy efficiency and changes in supply structure;

(ii) role of nuclear energy as a suitable alternative for reducing CO_2 emissions.

The summary report of the Energy Working Group is reproduced below.

'While energy conservation and efficiency was already a goal in the past, this was so under the perspective of energy supply shortages. Now, energy efficiency improvements are also needed because they are directly related to reduction of CO_2 and other greenhouse gases.

Targets for energy efficiency improvements should be directly related to reductions in CO_2 emissions by 10% by 2005.

Targets for energy supply should be directly related to reductions in CO_2 and other greenhouse gases. A challenging target would be to achieve energy supply improvements which reduce total annual global CO_2 emissions by 10% by 2005, in addition to that achieved through efficiency measures.

Biomass is an important energy resource in developing countries today and is often used inefficiently. Research and demonstration projects to accelerate the development of advanced biomass conversion technologies could make a powerful contribution to conserving the world's biomass stock and reducing the rate of increase of atmospheric carbon dioxide. Reducing deforestation and accelerating reforestation, in addition to replenishing the primary energy supply for the majority of the world's population, could make a significant contribution to reducing the atmospheric concentration of CO_2.

The rising concerns over the consequences of CO_2 and other gaseous emissions point out the need to revisit the nuclear power option which lost some credibility due to problems related to nuclear safety, radioactive wastes, and nuclear weapons proliferation. If these problems can be solved, through improved engineering designs and institutional arrangements, nuclear power could have a role to play in lowering CO_2 emissions.

It is necessary to internalize externalized costs, and thereby to consider the costs of energy systems in the broadest sense.

On this basis, policies should be fashioned to achieve broad, complementary social objectives and to minimize total social, economic and environmental costs.'

On the last day of the conference the Dutch Environment Minister Nijpels indicated that the Netherlands would host a follow-up conference.

Visit by the Energy Economists Group of the Institute of Petroleum (29 and 30 September 1988)

A seminar was arranged by DG XVII on 29 and 30 September at the request of the Institute of Petroleum. Some 30 economists from a wide range of oil companies and consultant firms attended and were accompanied by Mr A.E. Williams, Director-General of the Institute, and Mr T. Radford, Chairman of the Energy Economists Group. The purpose of the visit was to improve the group's understanding of Community policies and legislation affecting the oil industry and to provide an opportunity for the concerns of UK companies to be made known to the Commission.

Various aspects of energy policy and of the internal market project took up a large part of the seminar but there were also sessions on energy balances, the electricity sector, refining and import policy, environmental legislation and the oil monopolies. For the Institute Mr Williams explained the functions of the organization and touched on its concerns about legislation on the internal market.

The first related to the role of the Commission in establishing *standards, specifications and test methods* and the extent to which, with the completion of the market, this would take over the functions of well-established and respected national organizations in the UK and preclude the acceptance of US standards.

The Commission representatives reassured the visitors that there was no intention of taking over the role of national organizations or to challenge the acceptance of US standards used throughout the international industry. The Commission generally only initiated legislation in this area when its intervention was requested by industry and there was demonstrably a need to fix certain parameters at Community level. The directive requiring the introduction of unleaded gasoline and establishing a *minimum* octane number for it was cited as an example of such intervention. In this case the Commission had stipulated only the essentials and left to national bodies, coordinated by CEN, the development of detailed specifications. The principle of mutual recognition was also mentioned as limiting the amount of Community legislation required.

Oil product taxation was the other subject to attract great interest and criticism of the Commission proposals. IP representatives reiterated the complaint heard from so many other bodies that the proposals appeared to have been made without regard for their energy policy or environmental implications (e.g. increase in diesel fuel, decrease in unleaded gasoline consumption). Criticism centred on the exclusion of natural gas, which speakers thought should be treated in the same way as gasoil, and the relationship between the taxes on motor gasoline and diesel fuel. The proposal would result in a much larger differential in the UK in favour of diesel fuel and a consequent major change in the proportion of each fuel consumed. This could render redundant a part of the investment made to produce unleaded gasoline and make necessary new investment in hydrocracking plant. It was acknowledged that exchanges with other Member States would help to redress the imbalance but it was pointed out that transport costs would be high. The Commission representative explained the present status of the proposal which will be discussed in Council in 1989.

A full report of the meeting was published in the Petroleum Institute's publication *Petroleum review*.

Tunis seminar

Commission of the European Communities — Tunisian Energy Management Agency (AME)

The Commission of the European Communities held a seminar on the subject of energy analysis and prospects for 2010-25 in the Mediterranean area in Tunis from 5 to 7 October in conjunction with the AME, a body reporting to the Tunisian Ministry for Energy and Mines.

The objective was to define a harmonized method of analysis, by comparing experience with long-term energy consumption modelling and forecasting so as to prepare joint energy scenarios for the Mediterranean area.

The exchange of experience was intended to result in an assessment of energy planning cooperation projects on the lines of the Commission's endeavours in other regions of the world (Latin America, Asia).

Fifteen Mediterranean countries were represented: Portugal, Spain, France, Italy, Yugoslavia, Greece, Cyprus, Turkey, Syria, Egypt, Jordan, Libya, Tunisia, Algeria and Morocco.

Some independent communities and regions were also represented: Madeira, Alentejo (Portugal); the Basque country, Catalonia, the provinces of Murcia, Valencia and Seville (Spain); Provence Côte d'Azur (France).

The European Investment Bank, the World Bank, the Organization of Arab Petroleum Exporting Countries and the United Nations (Blue Plan) also sent representatives.

All in all, there were over 70 delegates at the seminar, which focused on four topics.

The first topic was the institutional environment of the energy forecasting process, since it is essential to have those responsible for energy policy and representatives of the energy industry involved in the exercise if it is to succeed in practice.

Another topic concerned a stocktaking of the main forecasting models and methods available, which enabled all concerned to note the similarity of the instruments used (technical-economic models of the Medee and EFOM type sponsored by the Commission).

The third topic was a description of the energy demand forecasting studies carried out in the various countries; optimum exploitation of oil and gas reserves in Algeria, Libya and Egypt; dependence on energy imports in other countries and so on.

The last topic was the preparation of a consistent scenario for energy analysis for the Mediterranean area; the Commission's experience with international studies served as a reference.

A whole day was set aside for round tables to discuss the statistical harmonization of national energy accounts so as to facilitate international comparisons and studies.

The question of Mediterranean energy scenarios also entails identifying the major factors of change by 2010 resulting from a comparison of the projects and strategies in question: the ageing of the population in the northern Mediterranean/population growth and youthfulness in the south, environmental constraints in the formulation of energy policies, indebtedness and the risks of technological dependence, complementarity of wealth and the prospects of technical, economic and financial cooperation.

The seminar proceedings will be published shortly.

Conference on recent advances in heat exchangers

At the instigation of the European Federation of Energy Management Associations (EFEM), the Group for Research on Heat Exchangers (GRETh) organized a European conference on recent advances in heat exchangers as part of TEC 88 (European Forum of Competitive Technologies) in Grenoble on 12 and 13 October 1988, an event sponsored by the Commission of the European Communities.

This conference, which brought together over 180 industrialists, researchers and academics from all over Europe, was intended for users and manufacturers of heat exchangers and engineering companies. Papers were given on improvements to heat exchanger performance and technology and new heat exchanger designs.

The conference was opened by Mr G. Fournier, EFEM President, followed by speeches by Mr J. Bouvet, Head of the French Energy Management Agency, on his Agency's open approach to Europe and by Mr C. Jones, Deputy Director-General for Energy in the Commission of the European Communities, on EEC energy policy.

Some 25 papers were read during the six technical sessions on:

(i) Results of past EEC programmes and preview of forthcoming programmes, i.e. the R&D programme on heat exchangers run by Directorate-General XII and the energy demonstration projects run by Directorate-General XVII. A progress report was given on the work of the European Committee for Standardization (CEN), which is drafting five standards on heat exchangers.

(ii) Heat exchanger theory, notably a method of seeking the minimum pinch effect in exchangers and exchanger arrays together with expert systems for heat exchanger selection.

(iii) Improvements in heat transfer performance: theoretical possibilities such as the use of non-uniform flows in heat exchangers were discussed, together with papers on practical applications of finned plates in plate heat exchangers or of high-performance corrugated tubes (with porous or grooved surfaces) in shell-and-tube exchangers.

(iv) Compact exchangers: particular interest was shown in finned plate exchangers, first used for low-temperature liquefaction processes but likely to come into wider use in the future in a variety of processes in the chemical and petrochemicals industries. A paper was given on compact ceramic cross-flow exchangers capable of operating at up to 1 200°C.

(v) Modelling of heat exchangers, including the development of software for three-dimensional thermohydraulic calculations to predict single-phase and, soon, two-phase flows in the shells and/or the fluid inlets or redistributors between trips through the exchanger. This software is extremely useful for shell design and for determining dimensions and volume (to avoid redundancy) and for producing the best possible designs of, for example, exchanger coils.

(vi) New exchanger designs. This session opened with an outstanding paper on exchanger materials capable of withstanding high temperatures, notably ceramics and plastics, some of which can already operate at temperatures of up to 150°C with 250°C likely in the near future. New exchanger designs were described: for example, heat pipe exchangers, of which a 1.3 MW prototype has been operating for the last two years or more at a refinery, where it recovers heat from the 400°C furnace discharges to the user's complete satisfaction; a 125 kW ceramic gas-gas exchanger operating by spraying jets of gas onto silicon carbide walls at up to 1 400°C with a coefficient of performance of 0.5; finally a self-cleaning fluidized bed exchanger capable of exploiting potentially fouling gases or vapours without impairing exchanger performance.

The subsequent discussions covered three main topics:

(i) Technical aspects

The role played by the materials chosen was strongly emphasized: better use must be made of familiar materials (metals, alloys, ceramics and plastics) by more systematically harnessing the aids to mechanical and thermal calculations. At the same time, exchanger layout must be adapted to the new materials being introduced (ceramics and plastics).

The development of combined-cycle and high-temperature processes called for more work on high-temperature gas-gas heat recovery units in general, and ceramic units in particular.

(ii) Design aids

With the European heat exchanger market expected to grow by 4.9% a year over the next 10 years (according to Frost and Sullivan), the programme to improve exchangers in general must continue, with work on shell-and-tube exchangers, fouling prevention and compact exchangers (laminar flow and use of brazed aluminium). Further improvements were needed in the already highly effective aids for calculating the mechanical and thermal properties of exchangers, particularly plate-type heat exchangers (where clearance is a highly sensitive parameter). Software compatibility is another important factor in day-to-day use of such computer aids.

Thermomechanical problems were becoming increasingly crucial in compact exchangers and heat recovery units.

Professor Le Goff outlined exchanger selection criteria, drawing a distinction between subjective and objective costs.

Tooling and tolerance compliance costs could be reduced if the impact of manufacturing faults on performance were calculated at the design stage.

(iii) Action to make Europe more competitive

In addition to the abovementioned points and to the action by Commission DGs XII and XVII, the speakers stressed the need to promote standards for plate-type exchangers, similar to those already adopted for tube-and-shell exchangers. Such standards would facilitate transfer of the know-how widely shared by designers to students who would be the future users.

More generally, greater coordination of the work being done in Europe was desired. Without impairing inter-firm competition, it would be very useful to circulate summaries of the progress on, for example, fouling or methods of improving heat transfer.

In conclusion, this was an extremely lively round table at which a host of questions from the audience were answered. It illustrated the strong demand from industry for product enhancement and the spirit of innovation prevailing in the heat exchanger field.

In parallel with the conference, an exhibition was held of 25 displays, most of them concerning new exchanger designs from corrugated tube exchangers for refrigeration units, to porous matrix tube evaporators, free-falling film evaporators for viscous liquids, exchangers for three-phase particle streams, compact high-temperature metal exchangers, graphite exchangers, welded plate exchangers, etc. Continuous anti-fouling processes for shell-and-tube and plate-type heat exchangers were also presented. Finally, a number of displays focused on exchanger modelling, particularly for the transient phase.

A two-volume ('communications' and 'posters') summary of the proceedings of the conference is on sale from ATEE, 47 Avenue Laplace, 94117 Arcueil, France.

Energy cooperation with China

Clive Jones, Deputy Director-General for Energy (DG XVII) led a small team of Commission officials on a visit to China between 13 to 22 November 1988. The purpose of the visit was to negotiate and agree on the annual cooperation programme China (SSTC)-EC (DG XVII) on energy planning for 1989. Meetings started in Shanghai with Municipal Science and Technology Commission and the Shanghai Jiao Tong University (a study contract was signed on energy/environment interactions in Shanghai) and with representatives of the Nanjing and Hangzhou, China-EC energy management training centres.

Meetings were then held in Fuzhou, Fujian Province (S.E. China) with the Provincial Science and Technology Commission, the Institute of Geothermal Utilization of Fujian, Academy of Agricultural Science and the Fuzhou Institute of Energy Research with the purpose of defining appropriate cooperation activities on the geothermal energy source of Fuzhou. The EC Delegation was received by the Vice-Governor of Fujian Province.

The final meetings were held in Beijing with the State Science and Technology Commission, the State Planning Commission, the Ministry of Energy, the National Nuclear Safety Administration, the China Coal Corporation and with the Tsinghua University (INET) following which the 1989 cooperation programme was signed by Mr Jones, on behalf of CEC-DG XVII and Mr Wu Wufeng, the General Secretary of the SSTC. The activities of the programme are along three main axes: training, energy planning activities and resource development. Mr Ruan (Vice-Chairman of SSTC) hosted an official banquet for the EC Delegation.

Visit of Mr Maniatopoulos to the Middle East — 1 to 12 December 1988

A delegation from the Commission, led by Mr Maniatopoulos, Director-General for Energy, visited Kuwait, Saudi Arabia, the United Arab Emirates and, for the first time since 1979, Iran.

In addition to the annual meeting with OAPEC (Organization of Arab Petroleum Exporting Countries) which took place in Kuwait, the visit also had as an objective the consolidation of the image of the Commission and, by association, the Community in a strategically important region and the collection of first-hand information on the views and policies of the main actors in the oil world. In the light of the end of hostilities between Iraq and Iran and the unanimous agreement reached by OPEC at its meeting at the end of November the visit took on an added importance.

With the above in mind, Mr Maniatopoulos had meetings with a large number of important people in the oil and energy fields in the region, in particular the Oil Ministers of Iran and Kuwait, the Oil Vice-Minister for Saudi Arabia and the Secretary-General of the Gulf Cooperation Council (GCC).

It was clear that there was a favourable attitude in Iran to long-term cooperation with the Community. Concerning the scope of this cooperation, it was agreed that a pragmatic and realistic approach by the Commission should limit itself to a regular exchange of views, without, however, excluding some technical cooperation if the occasion presented itself.

Cooperation with Peru on gas

DG XVII first met the Peruvian energy authorities in December 1986, when a delegation of Commission officials visited the country to map out a programme of cooperation on energy planning.

The launching of this programme coincided with the discovery, in the Amazonian (Camisea) region, of a giant gasfield which, once on stream, can be expected to revolutionize Peru's energy situation and future. The field contains proven reserves estimated at 200 billion cubic metres of natural gas plus 200 million barrels of condensates.

At the request of the Peruvian authorities, the Commission immediately sent a team of top experts in:

(i) contract negotiations (to negotiate with the company which struck the field); and

(ii) technical studies on infrastructure (the gas pipeline to the Pacific coastal region, particularly Lima) and potential markets.

Early this year the negotiations on exploitation of the giant Camisea field culminated in conclusion of a basic contract in very acceptable time for talks of this type. The expertise provided by the Commission was a major factor in this rapid success.

The technical studies left no doubt that the project is highly viable. The initial heavy outlay (around USD 1.3 billion, including USD 700 million for the 580 km pipeline) will have a payback period of less than three years, thanks in particular to the export of condensates in addition to the gas. Use of the gas on the Peruvian market will save the country up to 55 000 barrels of oil a day. It will cover the demand for energy in Peru for decades at a time when the country was in danger of becoming a net energy importer. The field is scheduled to come on stream in 1993.

The Peruvian Government has asked the Commission to fund further studies to provide the requisite technical and financial back-up for the project. In view of the financial and technological stakes, the plan is to promote a coordinated European approach to continue the programme along the same lines.

Alongside this specific programme on gas, DG XVII is keeping up its support (technical assistance and training) for energy planning in Peru. This logical extension of the natural gas programme will help to decide the exact role to be played by this new source in Peru.

Energy technology projects

Oil and gas

Financial support for technological development projects in the oil and gas sector — Publication of the 1989 invitation to submit proposals

In accordance with Regulation No 3639/85, on 22 July 1988 the Commission granted financial support totalling ECU 36 million for 46 technological development projects in the oil and gas sector.

This Decision marked the end of the 1988 round of support set in motion on 7 August 1987 with the publication in the Official Journal of an invitation to submit proposals. European companies responded by submitting 83 applications for support for technological development projects costing an estimated total of ECU 244 million. Although the number of projects was 60% lower than in 1987, the total investment was down by just 26%.

After consulting the Advisory Committee for oil and gas projects, the Commission selected the projects to be supported in the light of the criteria of Regulation No 3639/85.

Priority was given to projects designed to reduce costs, increase safety and improve the efficiency of operations in areas of advanced technology. Preference was also given to projects involving at least two firms based in different Member States and to proposals submitted by small companies. Eleven (26%) of the projects selected will be joint ventures.

The projects selected are drawn from all the areas of activity covered by the Regulation. Production remains the biggest area, with 18 projects taking 46% of the support granted, followed by exploration (18%) and environmental impact (10%).

The Council, the European Parliament and the Member States were notified of the Commission's Decision on 28 July 1988. It had entered into force 15 working days later, since no Member State had referred the Commission's Decision to the Council in the meantime.

The invitation to submit new proposals for 1989 — the last year covered by Regulation 3639/85 — was published in Official Journal C 215 of 17 August 1988. The closing date for the submission of proposals was 16 January 1989.

Public opinion in the European Community on energy — 1987

In October/November 1987, a study of the public opinion on energy questions was carried out in the 12 countries of the European Community on behalf of the Directorate-General for Energy (DG XVII) of the Commission of the European Communities.

Questionnaires containing about 30 questions were put to national samples representative of the total population aged 15 years and over. In total, 11 600 people were interviewed in their homes by professional researchers.

The survey was conducted by 12 specialist institutes, together constituting the 'European omnibus survey', under the general coordination of Hélène Riffault and Jean-François Tchernia (Faits et Opinions, Paris).

Topics covered in the questionnaire included the perception of energy problems and views on energy consumption, energy policy, the different energy sources and nuclear energy.

A copy of the report (in English or French) can be obtained, free of charge, by writing to:

The Librarian
DG XVII — Energy
Commission of the European Communities
200 rue de la Loi
B-1049 Brussels
Belgium

Telefax: Brussels (32 2) 235 01 50

Anaerobic digestion — a video

The Directorate-General for Energy of the Commission of the European Communities has produced a film on anaerobic digestion and its industrial applications for the production of biogas (research and development projects, pilot projects and demonstration and industrial plants) in the context of the demonstration programme for biomass and energy from waste.

The film has been made by the Scientific Cinematographic Section of the National Research Committee in Bologna (Italy) with the help of research bodies and institutes and firms in various Community countries, and is available to anyone with an interest in anaerobic digestion.

It is available in a 16 mm version (lasting 40 minutes) or on videocassettes (3/4" U-matic, VHS, betamax and 8 mm, PAL or Secam), with a soundtrack in English, French, German, Italian or Spanish.

Please send orders to the following address:

Professor Lucio Morettini
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Via dell'Inferno, 5
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Telex: 52350 Bologna
Telefax: 051 229702

Brochure on national laws and regulations relating to natural gas in the EEC

The Commission of the European Communities has just published a brochure on the national laws and regulations relating to natural gas in the different Member States of the European Community.

This compendium, which is available in three languages (English, French and German), is based on contributions from gas experts in the Member States.

It covers all Member States except Greece and Portugal. These countries do not yet have laws relating to natural gas.

The brochure contains information on the present laws and regulations in the areas of exploration and production, transport, storage, distribution, importation and exportation of natural gas.

The brochure — EUR 11433 — is available from the Office for Official Publications of the European Communities, L-2985 Luxembourg, at a price of ECU 8.75.

Forthcoming events

European Small Hydropower Association (ESHA) and International Small Hydropower Conference — Madrid, 22 to 25 May 1989.

A new European Small Hydropower Association (ESHA) has been created to bring together all those with an interest in small hydro. The aims of the Association are to protect and promote the interests of small hydro in general and in representations to governments, the European Community, and other official bodies; to exchange information and experiences between its members; and to inform the public at large of the advantages of hydroelectric energy. To help achieve these objectives the Association will circulate a regular newsletter to its members, and organize conferences, seminars and other events. The Commission of the European Communities also intends to use ESHA to help disseminate the results of their small hydro energy technology demonstration programme, a programme to demonstrate innovative technology in this field. Membership fees are ECU 40 for individual members and ECU 200 for corporate members.

The Association, in conjunction with the Spanish Institute for the Diversification and Saving of Energy (IDAE), and the Commission of the European Communities, are organizing a conference and exhibition on small hydropower, to be held in Madrid on 22 to 25 May 1989. The conference will have speakers from all interested sectors, including: industry, users, utilities and the European Commission. It will cover all topics concerning the development of hydropower, and in particular small hydro, including: authorization procedures, environmental questions, economic aspects and finance, technological developments, and small hydro in developing countries. The conference fee is ECU 200, (ECU 150 for ESHA members).

For details on how to apply for membership of ESHA and/or for attendance at the International Hydropower Conference, please write to:

The Secretary, The European Small Hydropower Association, Instituto para la Diversificacion y Ahorro de la Energia (IDAE), Paseo de la Castellana 95, 28046, Madrid, Spain.

Document update

Main Commission energy documents, proposals, directives

SEC/88/227	Draft Commission Decision concerning the granting of financial aid to 61 technical coal research projects for 1988
COM/88/316	Modification à la proposition de recommandation du Conseil aux Etats membres portant sur le développement de l'exploitation des énergies renouvelables dans la Communauté
SEC/88/376Fin	Communication from the Commission on a Community regime for procurement in the excluded sectors: water, energy, transport and telecommunications
SEC/88/377Fin	Proposal for a Council directive on the procurement procedures of entities providing water, energy, and transport services
COM/88/380	Report from the Commission to the European Parliament and the Council on the application of Council Regulation (EEC) No 3639/85 of 20 December 1985 on the support of Community projects in the hydrocarbons sector
COM/88/388	Proposal for a Council decision adopting a specific research and technological development programme in the field of energy — non-nuclear energies and rational use of energy (1989-92) 'Joule' (Joint opportunities for unconventional or long-term energy supply)
COM/88/415/Fin	Proposal for a Council Decision adopting a research and technological development programme for the European Atomic Energy Community in the field of the decommissioning of nuclear installations (1989-93) OJ C 250 1988
COM/88/491	Communication from the Commission — The oil market and the refining industry in the Community: recent developments and the prospects until 1995
COM/88/541	Commission report on the application of Community rules for State aid to the coal industry in 1987
COM/88/576	Proposal for a Council decision on a Community action programme for improving the efficiency of electricity use
SEC/88/1295	Council Directive (85/536/EEC) of 5 December 1985 on crude oil savings through the use of substitute fuel components in petrol Commission staff working paper
C../88/1368	Commission Decision of 22.7.1988 on the granting of financial support for demonstration projects in the field of technological development of hydrocarbons
C../88/1434	Commission Decision of 26.7.1988 on the granting of financial support for demonstration projects in the field of substitution of hydrocarbons by solid fuels
C../88/1435	Commission Decision of 26.7.1988 on the granting of financial support for demonstration projects and pilot industrial projects in the field of liquefaction and gasification of solid fuels
SEC/88/1590	Communication from the Commission to the Council Memorandum on the financial aids granted by Spain and Portugal to the coal industry in 1986

New energy publications

'Recueil des textes législatifs et des actes relatifs au domaine de l'énergie'. Situation au ler janvier 1988. *Objectif 92: une Europe sans frontières.*
Office for Official Publications of the EC — Luxembourg — 742 pp. ISBN 92-925-8725-8

European Community-Canada relations
Framework agreement on commercial and economic cooperation, sectoral agreements (Nuclear cooperation, fisheries, environment). Trade relations.
European Community news — Delegation of the Commission of the EC Ottawa No 7 (13 June 1988) 5 pp.

Euratom Supply Agency — Annual Report 1987
Office for Official Publications of the EC. 1988. 58 pp. ISBN 92-825-8634-0

European Community demonstration projects for energy saving and alternative energy sources

EE/067/83-DE DE-EN No 83 — Vaillant
Field test with absorption heat pump of small capacity
Feldtest mit Absorptionswärmepumpen kleiner Leistung

EE/021/82-IT EN-IT No 84 — Italsvenska
Dry process for the production of mixtures for ceramics with greater energy saving
Processo a secco per la produzione di impasti per ceramica con maggiori risparmi energetici

EE/124/83-IT EN-IT No 85 — SNAMPROGETTI
MAS Technology (Simultaneous production of methanol and higher alcohols)
Tecnologia MAS (Produzione simultanea di metanolo e alcoli superiori)

SE/594/83-UK EN-FR No 86 — Wimpey Laboratories Ltd
A passive solar heating facility for existing houses
Installation de chauffage solaire passif pour des logements existants

EE/017/82-IT EN-IT No 87 — Consorzio Recupero Cromo SpA
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BM/318/84-FR EN-FR No 89 — SGN
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Le Bus de l'Energie — un moyen pour améliorer l'efficacité énergétique

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Elsevier Applied Science
ISBN 1 85166 185 9

'Biomass energy' (EN)
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Elsevier Applied Science
ISBN 1 85166 175 1

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Office for Official Publications of the European Communities — Luxembourg

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Proceedings of a workshop organized by the CEC
Berlin, 19 and 20 October 1987
Edited by J. Sirchis
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'Solar-heated swimming pools'
Energy demonstration programme
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'Third-party financing for energy savings'
Proceedings of a seminar held in Luxembourg, 8 and 9 October 1987
Edited by D. Fee
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'Energy recovery through waste combustion'
Proceedings of a seminar held at Churchill College Cambridge, 21 to 24 June 1988
Edited by A. Brown, P. Evemy and G.L. Ferrero
Elsevier Applied Science
ISBN 1 85166 285 5

Statistics

Supply of coal to public power stations and all coking plants in 1987.
Energy — Rapid reports No 9 — 1988
Statistical Office of the EC. 1988. 16 pp.

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